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THE

ANATOMY

OF THE

HUMAN BODY.

BY WILLIAM CHESELDEN,
Surgeon to his Majesty's Royal Hospital at Chelsea, Fellow of the Royal Society, and Member of the Royal Academy of Surgeons at Paris.

With Forty Copperplates.

SECOND AMERICAN EDITION.

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William Cheselden a surgeon of note Born at Somerby in Leicester-Shire 1688, Died 1752 of apopley-aged 64 — at head Surgeon of chelsea Hospital

TO

DR. RICHARD MEAD,

PHYSICIAN TO THE KING,

FELLOW OF THE COLLEGE OF PHYSICIANS

IN LONDON;

AND OF THE

ROYAL SOCIETY.

SIR,

EVERY part of PHYSIC may justly presume on your protection, to whom it owes so much improvement. ANATOMY in particular has received such advantage from your LECTURES, that it were a kind of injustice not to dedicate all endeavours in that way to you; in me, indeed, it would be unpardonable not to offer the fruits of those studies, which at first began, and have still been carried on with your encouragement. The kind reception my industry has met with, is owing to you, the authority of whose

opinion has in every place secured me so much favour ; especially in that seat of learning, which with distinguished honours rewarded your merit.

I am, SIR,

Your most obliged and

Obedient humble servant,

WILLIAM CHESELDEN.

PREFACE.

THE study of ANATOMY, *as it leads to the knowledge of nature and the art of healing, needs not many tedious descriptions nor minute dissections; what is most worth knowing, is soonest learned, and least the subject of disputes; while dividing and describing the parts, more than the knowledge of their uses requires, perplexes the learner, and makes the science dry and difficult.*

This edition is a tenth part larger than the former; not increased by descriptions, but by observations upon the uses and mechanism of the parts, with operations and cases in Surgery.

The plates are more in number, larger, better designed, and better executed than those which were in the former editions, which has unavoidably enhanced the price of this.

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ADVERTISEMENT.

SINCE the last edition of this book, I have published some Observations and Cases in Surgery, with prints of Operations and a Set of Chirurgical Instruments. These are annexed to a Translation of LE DRAN's Operations by Mr. GATAKER; and as some of them relate to my Anatomy, I thought it proper to take notice of them here: at the same time, in justice to the merit of Mr. LE DRAN, I would recommend a careful perusal of his Book to all Practitioners in Surgery.

W. CHESELDEN.

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GENERAL INTRODUCTION.

IT is a received opinion, that an animal body is a compages of vessels, variously disposed, to form parts of different figures, for different uses. The ancients supposed that the heart and brain were first formed, and that the other parts proceeded from them, and that the membranes were derived from the dura mater, or pia mater of the brain. They distinguished all the parts into spermatic and sanguineous; the former of which they derived from the brain, and the latter from the heart; and frequently engaged in disputes about the derivation of parts; with many other things of the like nature, consequences of their hypotheses. But the moderns, by the assist-

ance of glasses, having made more accurate observations, conclude, that all the parts exist in miniature, from the first formation of the fœtus ; and that their increase is only the extension and thickening of their vessels, and that no part owes its existence to another. Thus much I thought necessary to premise, that the reader might see for what reason no notice is taken, in this treatise, of some distinctions and divisions of parts, used by ancient anatomists, and those who have copied after them.

The constituent parts of the animal body, are, fibres, membranes, arteries, veins, lymphæducts, nerves, glands, excretory vessels, muscles, tendons, ligaments, cartilages, and bones ; to these may be added, the hair and nails.

Fibres, as they appear to the naked eye, are simple threads of the minutest blood vessels or nerves, or both.

Membranes are compages of fibres, expanded to cover, or line, any other part.

Arteries are tubes that arise from the ventricles of the heart, and thence dividing into branches, distribute the blood to every part of the body.

Veins are tubes to collect and return the blood from the extremities of the arteries to the heart.

Lymphæducts are fine pellucid tubes, to carry lymph from all parts, especially the glands, which they discharge into the larger veins, and into the vasa lactea.

Nerves are fasciculi of cylindrical fibres, which arise from the medulla oblongata of the brain, and the medulla spinalis, and terminate in ail the sensitive parts. They are the immediate organs of sensation.

A gland secretory, is composed of an artery, vein, lymphatic, excretory duct, and nerve. The use of glands is to secrete fluids from the blood, for divers uses.

Excretory vessels are either tubes from glands to convey the secreted fluids to their respective places; or vessels from the small guts, to carry the chyle to the blood vessels; these last are called vasa lactea.

Muscles are distinct portions of flesh, which by contracting, perform the motions of the body.

Tendons are the same fibres of which the muscles are composed; but more closely connected, that they may possess less space in a limb, and be inserted in less room into a bone.

Ligaments are strong membranes, or bodies of fibres closely united, either to bind down the tendons, or give origin to the muscles, or tie together such bones as have motion.

Cartilages are hard, elastic bodies, smooth and insensible; their use is to cover the ends of the bones that have motion, to prevent their attrition, &c.

Bones are firm parts to sustain, and give shape to the body, &c.

INTRODUCTION TO THE BONES.

THE use of the bones is to give shape and firmness to the body, to be levers for the muscles to act upon, and to defend those parts from external injuries that are of greatest consequence to be preserved; as the brain, spinal marrow, heart, &c. Their fibres, when first formed like the shells and stones of fruits, are very soft, until by the addition of a matter, which is secreted into them, they grow by degrees to the hardness of a cartilage, and then perfect bone: but this change is neither made in a very short time, nor begun in all the parts of the same bone at once. Flat bones, that have their fibres directed to all sides, begin to ossify in or near a middle point; but the cylindrical bones, and all others whose fibres are nearly parallel, begin about the middle of each fibre, and thence shoot forth to their extremities; not always in continued lines, but frequently beginning new ossifications, which soon join the former; and by the continual addition of this ossifying matter, the bones increase till their hardness resists a farther extension; and their hardness always increasing while they are growing, the increase of their growth becomes slower and slower, until they cease

to grow at all. In old and consumptive persons, and sometimes in diseased or wounded limbs, they decrease as well as the fleshy parts, though not so fast, because of their hardness. Sometimes the ossifying matter flows out of the bones, and forms bony excrescences ; and frequently in very old men it fixes on the arteries, and makes them grow bony ; and when this happens to a degree, the arteries lose their power to propel the blood, until the extreme parts mortify. And though the cartilages and arteries are most subject to these changes, yet no part is secure from them ; for I have seen a large part of the muscular fibres of the heart itself perfectly ossified. I have known one instance of a deficiency of this ossifying matter, in the lower jaw of an adult body ; where all that part on one side, which is beyond the teeth, was of a substance between that of a cartilage and a ligament. In children that have died of the rickets, I have found the nodes on the bones soft, spongy, and bloody, and in one subject several of them as limber as leather, and the periostæum in some places many times its natural thickness ; but the cartilages and cartilaginous epiphyses had no apparent alteration in their texture, though some were swelled to more than twice their natural diameters.

Every cylindrical bone has a large middle cavity, which contains an oily marrow, and a great number of lesser cells towards their extremities, which contain a bloody marrow. The bloody

marrow is also found in all spongy cells of bones. The use of the first kind of marrow, I imagine, is to soften, and render less brittle, the harder fibres of bones near which it is seated; and that the other marrow is of the same use to the less compact fibres, which the more oily marrow might have made too soft; and that for this reason there is less of the oily marrow, and more of the bloody, in young bones than in old ones. Every one of these cells is lined with a fine membrane, and the marrow in the larger cells is also contained in thin membraneous vesicles; in which membranes the vessels are spread, which enter obliquely, about the middle of the cylindrical bones, from some of whose branches the marrow is secreted, while others of them enter the internal substance of the bones for their nourishment; and the reason why they enter obliquely is, that they may not weaken the bones by dividing too many fibres in the same place. If the bones had been formed of the same quantity of matter without any cavities, they would, if they were straight, be able to sustain the same weight: but being made hollow, their strength to resist breaking transversely is increased as much as their diameters are increased, without increasing their weights; which mechanism being yet more convenient for birds, the bones of their wings, and for the same reason their quills, have very large cavities. But the bones in the legs of all animals are more solid, being formed to sup-

port weight ; and men's bodies being supported by two limbs, the bones of those limbs are therefore made more solid than those of quadrupeds. Insects, and most of the smallest animals, have shells instead of bones, like lobsters, which serve them also for defence ; and the muscles, being inserted into the shells at a greater distance from the centre of motion of each joint than in animals that have bones, their motions are necessarily slower, stronger and more simple. Therefore in this sort of animals, quickness of motion, where it is wanted, is procured by a number of joints, as may be seen in the legs of a flea ; and variety of motions by joints with different directions, as may be observed in a lobster. In a fractured bone, in which the same kind of matter that ossified the bones at first is thrown out from the broken ends of a bone, there is formed a mass of callous matter, of equal solidity with any part of the bone, and of equal or greater diameter, which will make the strength of the bone in that place greater than it was before ; which is very convenient ; for bones, when broke, are seldom or never set in so good a direction as that in which they were first formed, and therefore they would be more liable to be broke in the same place again, and would be reunited with greater difficulty, and sometimes not at all, because the callus, being less vascular than a bone, is does not so easily admit the ossific matter to flow through it to form a new callus.

Bones that are without motion, as those of the scull, the ossa innominata, &c. also bones with their epiphyses, when they meet, press into each other, and form sutures, which soon disappear in those that join, while their ossific matter is soft; but those that grow harder before they meet, press more rudely into each other, and make more uneven sutures, some of which in the scull endure to the greatest age: and sometimes while a bone is ossifying from its centre, a distant part begins a new ossification, and forms a distinct bone, which may happen to be of any figure. These bones are oftenest found in the lambdoital suture, and are there called ossa triquetra. But the ends or sides of bones that are intended for motion, are hindered from uniting, by the cartilages which cover them; for when these cartilages are eroded, the bones very readily unite, and form an anchylosis.

The ends of all the bones that are articulated for very manifest motions, or that are not placed against other bones; are tipped with epiphyses or additional bones; which in some measure determine their growth and figure; for if they had nothing to give bounds to them, they would shoot out like the callus from the broken ends of a bone that is ill set, and grow as ragged as the edges of bones which are joined by sutures; and sometimes epiphyses are made use of to raise processes upon bones for the insertions of muscles, as the trochanters of the thigh bones, where it would weaken

the bones too much to have processes raised out of their substance.

The fibres of bones, for aught that we can discover from experiments or microscopical observations, appear to be connected to each other by the same means that the parts of a fibre are connected, that is, by the strong attraction which belongs to particles of matter in contact; but this cohesion of fibre to fibre is not equal to that in the parts of a fibre, though very nearly. Indeed if it was, a bone would not be a structure of fibres, but one uniform mass, like that of any pure metal, the cohesion of the parts of which are every where alike. Nor are the parts of bones disposed into visible lamellæ, stratum super stratum, as many have painted; for though young bones may in some places be split into lamellæ, yet they not only appear one solid uniform mass to the naked eye, but even with a microscope, till we come to their inner spongy texture, which also appears uniform. Their texture, when first formed, is every where loose and spongy: but as they increase, they become in many places very compact and dense, which results in great measure from the pressure of the bellies of the muscles, and other incumbent parts; as appears from the impressions they make on the surfaces of the bones, and the rough spines that rise on the bones in the interstices of the muscles, which are very remarkable in men who have been bred up in hard labour. In those parts of the flat bones

that receive but little pressure, the outer laminæ only become compact and dense, while the middle part remains spongy; but where the pressure is greater, as on the scapula and the middle of the ilium, they become in an adult, one dense body or table, and are usually thinner in those places than in a child before it is born. The cylindrical or round bones, being pressed most in their middles, become there very hard and strong, while their extremities remain spongy, and dilate into large heads, which make stronger joints, and give more room for the origins and insertions of the muscles; and increase the power of the muscles, by removing their axis farther from the centre of motion of any joint they move.

All the bones, except so much of the teeth as are out of the sockets, and those parts of other bones which are covered with cartilages, or where muscles or ligaments arise or are inserted, are covered with a fine membrane, which upon the scull is called pericranium, elsewhere periostæum. It serves for the muscles to slide easy upon, and to hinder them from being lacerated by the roughness and hardness of the bones. It is every where full of small blood vessels, which enter the bones for their nourishment; but the internal substance of the larger bones is nourished by the vessels which enter obliquely through their middles, as has been before observed.

CHAPTER I.

SUTURES AND BONES OF THE CRANIUM.

A SUTURE is made by the mutual indentation of one bone with another. Those which have proper names are here described; those which have not, derive their names from the bones they surround, and are known by them.

Sutura coronalis runs across the scull, from one upper edge of the sphenoidal bone to the other, and joins the parietal bones to the frontal.

Sutura sagittalis joins the parietal bones; begins at the os occipitis, and is continued to the os frontis, in children down to the nose; the os frontis in them being two bones, and sometimes so in adult bodies.

Sutura lambdoidalis joins the back part of the ossa bregmatis, or parietal bones, to the upper part of the occipital: in this suture are frequently observed small bones called ossa triquetra, and sometimes in other sutures.

Sutura squamosa is made by the upper part of the temporal and spenoidal bones wrapping over the lower edges of the parietal bones.

Sutura transversalis runs across the face through the bottoms of the orbits of the eyes; it joins the lower edge of the frontal bone to the os spenoides, maxillæ superioris, ossa nasi, ungues plana, palati, and jugalia, or malarum.

The scull being divided into many bones, is neither so subject to fractures, nor to have fractures so far extended, as it would have been were it composed of one bone only. This structure is also convenient for the ossification of the bones, as has been already shewn, and for the birth; because these bones not being perfect at that time, may be pressed together, and make the head less.

Ten of the bones of the head compose the cranium, to contain the brain and defend it from external injuries.

Ossa parietalia, or bregmatis are two large bones which compose the superior and lateral parts of the scull; on the inside they are remarkably imprinted by the arteries of the dura mater.

Os frontis makes the upper and fore part of the cranium; its lower parts compose the upper parts of the orbits of the eyes, where on its insides are impressed the volvuli of the brain, which unevennesses help to keep that part of the brain steady. In its middle above the os ethmoides usually arises a thin spine, which strengthens that part of the bone, it being otherwise weak from its flatness. In some sculls this spine is wanting; but then the bone is usually thicker in that place, and from its middle, externally, goes a process which supports the bones of the nose. Immediately above the os ethmoides in this bone is a small blind hole, through which runs a vein into the beginning of the longitudinal sinus of the dura mater; and on the upper

edge of each orbit, a small perforation, or a notch, through which nerves and an artery pass secure to the forehead; it has also a small hole in each orbit, near the os planum, through which passes a branch of the fifth pair of nerves. In the substance of this bone near the nose are two, three, four, and sometimes five sinuses, which open into the nose; they differ very much in different persons, and are very rarely found in children. These sinuses, and the spine in this bone, make it very dangerous, if not impracticable, to apply a trephine on the middle and lower part of the forehead.

Os esthmoides, or cribriforme, is a small bone, about two inches in circumference, seated in the anterior part of the basis of the scull, being almost surrounded by the last described bone. It is full of holes, like a sieve, through which, it is said, the olfactory nerves pass, which I could never discover. In its middle arises a large process named crista galli: and opposite to this a thin one which in part divides the nose. The greater part of the laminæ spongiosæ in the nose belong to this bone.

Os sphenoides is of a very irregular figure; it is seated in the middle of the basis of the scull, bounded by the os frontis, ethmoides, vomer, occipitis, maxillæ superioris, ossa parietalia, palati, malarum, temporum, and petrosa, which are parts of the former bones. In its inside next the brain is a cavity named sella turcica, which is bounded by four processes called clinoides: under the two foremost

of which pass the internal carotid arteries, and from their outsides are continued two thin long processes upon that part of the frontal bone, which separates the anterior lobes of the brain from the posterior; opposite to the sella turcica is a process which makes part of the septum narium. On the outside of the scull adjoining to the upper jaw, are two processes of this bone on each side, named pterygoides from which arise one on each side near the palate, which have no name. Over these pass the tendons of the pterygostaphilina externi muscles; and nearer towards the occiput, between these and the styloid processes of the ossa petrosa, arise two more small rugged processes; and under the sella turcica, in this bone, is a sinus or two, for the most part, in adults, but in children only such a spongy substance as is seen in the ends of some of the bones. Dr. Nichols observes, this sinus belongs properly to the os ethmoides. At the inside of the basis of the two anterior clinoid processes are two round holes, which are the first foramina of the scull; through these the optic nerves pass; almost under these, towards the sides of the scull, are two irregular slits, named foramina lacera, or the second foramina of the scull, through which pass nerves and blood vessels into the orbits of the eyes; and under these, towards the occiput, are two round holes, which are the third foramina, through which pass nerves to the face; about half an inch nearer the occiput are two more, of an oval figure, which are the

fourth foramina, through which pass the largest branches of the fifth pair of nerves ; and a straw's breadth farther two very small ones, called the fifth foramina, through which those branches of the carotid arteries enter that are bestowed upon the dura mater. Between this last described bone and the ossa petrosa, are two large rough holes, in which I have seen large veins ; and from these holes, through part of the os sphenoides under the pterygoid processes, are small holes, through which pass arteries to the back part of the nose.

Ossa temporum are situated below the parietal bones, at the middle and lower parts of the sides of the scull ; they have each at their back parts one large spongy process, called mammillaris, or mastoideus, and from the lower and middle parts of each a process which joins the ossa malarum, named jugalis or zygomaticus.

Ossa petrosa lie between the former bones and the occipital bones, or are truly portions of the former bones, being never found separate in adult bodies. They have each on their outsides one long slender process called styliformis, and near the side of this process a foramen, which runs obliquely forwards into the scull, through which the carotid arteries pass to the brain ; these are the sixth foramina, and one foramen in the inside of the scull leading to the organs of hearing, which are the seventh foramina. The ridge on the upper parts of each of these bones helps to keep the brain steady,

and are strong supports to the thin and flat parts of the scull, which else would be exceeding weak. What remains of this bone belongs properly to a discourse on the organs of hearing.

Between the last described bones and the following bone are two large holes, which are the eighth foramina. Through these holes pass the eighth pair of nerves and lateral sinuses; sometimes they are two on each side, one for the nerve and one for the sinus. To these we may add another very small one on each side, through which pass the portiones duræ of the auditory nerves; and sometimes there is another for an artery.

Os occipitis makes all the back part of the scull; it is bounded by the sphenoidal, temporal, petrosal, and parietal bones; it has two small apophyses, by which it is articulated to the spine; near those apophyses are two small foramina, which are the ninth of the scull; through these pass the ninth pair of nerves; and between these is the great or tenth foramen, through which the medulla oblongata descends into the spine, the cervical arteries enter, and the cervical veins pass out. In the inside of this bone is a crucial spine impressed by the longitudinal and lateral sinuses: and on the outside, opposite to the middle of this spine, in some bodies, is an apophysis, and from that down to the great foramen a small thin spine. The spines in this bone are of the same use with those in the os frontis, &c. viz. to strengthen it.

The thinner parts of this bone are also defended by the muscles that cover them ; which provision is very necessary, because we can least defend this part, and blows here are of worse consequence than on any other part of the scull, because wounds in the cerebellum, which is underneath, are mortal. There are in most sculls a foramen behind each apophysis of the occipital bone ; through which pass sinuses from the lateral sinuses to the external cervical veins: by means of these communications, as in all other communications of the sinuses, the blood passes from those that happen to be surcharged by any posture of the head, into those that from the same posture would have been almost empty. Such sculls as want these foramina have two sinuses for the same purpose.

CHAPTER II.

OF THE BONES OF THE FACE, &c.

OSSA nasi make the upper part of the nose ; they form that kind of arch which is fittest to sustain such injuries as the nose is most exposed to.

Ossa malarum. These bones compose the anterior, lower, and outer parts of the orbits of the eyes ; they have each a short process, which process joins the processus jugales of the temporal

bones, and form arches which have been called ossa jugalia.

Ossa ungues are seated immediately below the os frontis towards the nose in the orbits of the eyes; whose anterior and inner parts they help to compose; and between each of them and the upper jaw is a foramin as large as a goose quill, into which the puncta lacrymalia lead, to carry off any superfluous moisture from the eyes into the nose.

Ossa plana are seated immediately beyond the foregoing bones, in the orbits of the eyes, and are near thrice as big. They are rather smooth surfaces of the os spongiosum, than distinct bones, and are very often imperfect.

Maxilla superior is always described single, though it is manifestly divided by a suture which is scarce ever obliterated; it has two processes, which join the os frontis, and make part of the nose; and another, which joins to the cartilage of the septum nasi. Its upper and outward parts make the lower parts of the orbits of the eyes; its lower side, all that part of the face under the cheeks, eyes, and nose to the mouth, and two thirds of the roof of the mouth. A little below the orbits of the eyes, in this bone, are two holes, and behind the dentes incisores one more, which divides into two, as it opens into the nose, on each side of the septum nasi. Between the posterior grinding teeth and the orbits of the eyes are two great sinuses, called antra maxillæ superioris, which open in the

upper part of the nose. And in the lower edge of this jaw are the alveoli, or sockets for the teeth. Part of the sides of these cavities, that lie next the nose, are only membranes which make the cavities like drums, perhaps to give a grave sound to the voice when we let part of it through the nose; but brutes not needing such variety of sounds, have these cavities open to the nose, and filled with lamellæ, which are covered with membranes, in which the olfactory nerves terminate, for a more exquisite sense of smelling than is necessary for men. Imposthumations sometimes happen in these cavities: the signs of this disease are, great pain about the part, matter in the nose on the side diseased, stinking breath, and rotten teeth. Mr. Cowper first described this case, and the cure; which is performed by drawing out the last tooth but one, or two, or more if rotten; and through their sockets making a perforation, into the antrum; or if drawing a tooth makes a perforation, which sometimes happens, and perhaps gave the first hint of this cure, then that opening must be enlarged, if it is not sufficient to discharge the matter.

Ossa palati are two small bones that make the back part of the roof of the mouth, and a small part of the bottom of each orbit. Between the ossa palati and os maxillare near the pterygoid processes of the sphenoidal bone, are too small foramina, through which arteries and nerves pass to the palate.

Os Vomer is seated between the bones of the palate, and the sphenoidal bone. It is also joined to the process of the ethmoides, and part of the lower jaw. Its fore part is spongy, and is continued to the middle cartilage of the nose. This bone and cartilage are the septum nasi.

Os spongiosum is usually treated as a distinct bone, though it is only the spongy laminæ in the nose, of the os ethmoides and ossa plana, but chiefly of the os ethmoides, to which it always adheres. In considering these lamellæ as a distinct bone, we follow the ancients, who did not distinguish the bones of the scull only, as they are divided by sutures, but according to the differences of their texture, figure, situation, or use. Thus they called these parts os spongiosum; a process of the temporal bone, joined to the os malæ, os jugale, &c.

Maxilla inferior is articulated with loose cartilages to the temporal bones, by two processes, named condyloides. Near these arise two more, called coronales, and at the inside of the chin a small rough processus innominatus. In the inside of this bone, under each processus coronalis, is a large foramin, which runs under the teeth, and passes out near the chin. In this foramen, the vessels pass that belong to the teeth; and in the upper edge of this jaw are the sockets for the teeth, which seldom exceed sixteen in each jaw; the four first in each are called incisores, the two next canini, the rest molares; the four last of these are named

dentes sapientiæ, because they do not appear till men arrive at years of discretion. The incisores and canini have only one single root, but the molares more; the eight first, two; and the rest, some three, some four, especially in the upper jaw; where also they are spread wider, because that jaw being more spongy than the other, the teeth need more space to fix them. Each of these roots has a foramen, through which pass an artery, vein, and nerve, which are expanded in a fine membrane that lines the cavity in each tooth. These vessels and membrane are the seat of the tooth-ache. The teeth of children cast off while they are growing; but the succeeding teeth arise in new sockets, deeper and larger than the former, for the jaws increasing faster than the teeth, must otherwise have left chasms between them, such as are in the mouths of brutes; but where teeth are drawn in adult bodies, the sockets close, and new ones very rarely succeed.

CHAPTER III.

OF THE BONES OF THE TRUNK.

THE bones of the trunk are those which compose the spine or chain of bones from the head down to the rump, the ribs and sternum, to which may justly be added the the ossa innominata.

The spine is composed of twenty-four vertebræ (each of which in a young child is three bones)

besides those of the os sacrum and coccygis ; seven belong to the neck, the first of which is called atlas, because it immediately supports the head ; its upper side has two cavities, into which the apophyses of the os occipitis are received ; but these two cavities together, unlike all other joints, are laterally portions of concentric circles, by which means they are but as one joint, and so suffer the head to move easily side-ways, which otherwise it could no more do than the knee, which also has two heads and two cavities. The under side of this bone has a very flat articulation with the next, which fits it for a rotatory motion. The second vertebra is called dentata, or axis, from a process which passes through the former bone, and is the axis upon which it turns ; nevertheless all the vertebræ of the neck contribute something to the rotatory motion of the head. The processus dentatus is strongly tied to the os occipitis, and to the atlas by ligaments to prevent its hurting the spinal marrow. Twelve of which belong to the back, five to the loins. The os sacrum is sometimes five, sometimes six bones, and the os occygis four. If this chain had been composed of fewer bones, they must have either not been capable of bending so much as they do, or have bent more in each joint, which would have pressed the spinal marrow, the ill consequences of which are sufficiently seen in persons grown crooked, or who have had distortions from external accidents.

The uppermost vertebræ of the neck being fixed behind the centre of gravity of the head, the neck is therefore so far bent forward as that the last of these vertebræ (which has a firm bearing upon these of the thorax) may be exactly under the centre of gravity. Those of the thorax are bent backwards, behind the centre of motion, to make room for the parts contained in the thorax; and that they might not be made too weak by the structure, they are formed for less motion than other vertebræ; and those in particular, which are bent farthest from the centre of gravity have the least motion. The middle vertebræ of the loins are again bent forwards under the centre of gravity, or near it; and from thence they go backwards to the os sacrum, where being fixed to the ossa innominata behind the centre of gravity, the articulation is therefore firm and without motion, and from thence the ossa innominata are so formed, as that their sockets, into which the thigh bones are fixed, where there is a free motion, are exactly under the centre of gravity. In brutes the spine is differently formed, according to the actions for which they are designed.

In all these vertebræ, except the first, is a middle anterior spongy body, by which they are firmly articulated with a very strong intervening ligament; and from the middle of the hind part of each, except the first, stands a process named spinalis, and from every one a process on each side,

called transversalis, and two superior, and two inferior short ones; by which the back parts of the vertebræ are articulated, named obliqui, superiores, and inferiores.

The fore part of the seven vertebræ of the neck, and two upper of the back, are flat forwards, to make room for the aspera arteria angula: the third and fourth of the back acute to give way to the vessels of the lungs and heart, and bent to the right side for the better situation of the heart, which makes that side of the breast more convex than the other, and therefore stronger; which seems advantageous to the right arm, its motions depending upon the support it receives from the breast. Hence, I think, it seems, that the almost universal preference of that arm is not an arbitrary thing, but founded upon observation, that it is capable of more perfect actions than the other.

The spinal processes of the second, third, fourth, and fifth vertebræ of the neck are forked, the two last long and horizontal, the three or four upper ones of the back like them, only a little declining, the middle ones of the back run obliquely downwards, and the processes of the remaining vertebræ become successively thicker, stronger, and less declining; those of the loins being horizontal, like the last of the neck. The muscles that are inserted into the spinal processes of the vertebræ of the neck and loins will act with more strength than those

of the back, because their processes being perpendicular to the spine, they are longer levers; besides, those of the back almost touch one another, to prevent much motion, because it would interrupt respiration; but more motion being necessary in the neck and loins, their processes are made fit for it.

The transverse processes of the vertebræ of the neck are perforated, for the admission of the cervical blood vessels, and bowed downwards, and hollowed, for the passages of the cervical nerves. The eight or nine upper ones of the back receive the upper ribs; and the rest, with those of the loins, serve only for origins and insertions of muscles.

Os sacrum has two upper oblique processes, some small spinal processes, and two foramina in each interstice of the bones it is composed of, both before and behind. Ossa coccygis have none of these parts.

Through every bone of the spine, the ossa coccygis excepted, is a large foramen, which together make a channel through the spine, in which is contained the medulla spinalis; and in each space between the vertebræ are two large holes for the nerves to pass out.

It is worth considering the provision which is made to prevent luxations in this chain of bones, such luxations being worse than any other, because of the spinal marrow which is contained within these bones. The bodies of the vertebræ are all in the

same manner connected by strong intervening ligaments or cartilages. In the neck the oblique processes of the received bone are wrapped over those of the receiving bone, which forbids their luxating forwards. The transverse processes, with a small apophysis of the body of the same bone, in like manner, secure them from slipping backwards; and an apophysis on each side of the body of the receiving bone, hinders them from slipping to either side. The vertebræ of the back are hindered from dislocating forwards by the same provision with those of the neck; and from luxating backwards, by the ribs which are fastened to the transverse processes of the inferior vertebræ, and against the back part of the body of the next superior: they also hinder them from dislocating to either side; but the last ribs are not fixed to the transverse processes of the vertebræ of the back, and therefore it is that luxations are most frequently seen in this part; but the vertebræ of the loins are received into deep cavities, and are tied with much stronger ligaments for their security. Each joint of the vertebræ, except the two uppermost, has two centres of motion, one upon the bodies of the vertebræ, when the trunk is bowed forward; and the other at the articulations of the oblique processes, when the body is bowed backwards; from which structure the extensors will have about twice the lever to act with, and consequently twice the power to raise the trunk into an erect posture, that they have to

carry it beyond that posture: for then the oblique processes begin to be the centre of motion, and give a like advantage to the benders. Without this contrivance it would be more difficult to keep the body erect, or to recover an erect posture with considerable strength after a bend of the body.

The ribs are twelve in number on each side; the seven uppermost are called true ribs, because their cartilages reach the sternum; and the five lowest are called bastard ribs. They are articulated to the bodies of the twelve vertebræ of the back, and all, except the two or three last, are articulated to their transverse processes, and the under side of the middle ribs are hollowed for the passage of the intercostal vessels. They defend the parts contained in the breast, and when they are drawn upwards, the cavity of the breast is enlarged for inspiration, and so the contrary. In two children, which I have dissected, I found the ribs broke inwards, and on the outside a very plain print of a thumb and fingers, occasioned by their nurses taking hold of their breasts, and hoisting them up on one hand, which being often repeated, had broke the ribs inwards like a green stick, without separating the broken ends of them. I have also very frequently seen the shape of children's breasts quite spoiled by such tricks, which have occasioned weakness of body, crookedness, and other diseases.

Sternum, or breast-bone, is generally made up of three spongy bones, sometimes more; to this the

two ribs are articulated by their cartilages, which sometimes in robust men have moveable joints, such as are seen in oxen, and other quadrupeds. At the end of the sternum is the cartilago ensiformis, so called from its shape, but it very often is double; there is also frequently found variety in the form of the cartilages, which join the ribs and sternum; sometimes one cartilage serving two ribs; and sometimes a cartilage not joined to any rib; frequently in old persons we find parts of them ossified, and I have twice found them totally ossified in men between forty and fifty years of age, both of which died with a great difficulty of breathing; and besides, one had a jaundice, and the other a dropsy, but the lungs in both were very sound.

There are seldom found fewer than four and twenty vertebræ in the spine, besides the os sacrum, but often more; sometimes thirteen of the back, with as many ribs of a side: and sometimes six in the loins, and in some bodies two ribs from the first vertebra of the loins, but then it has wanted transverse processes.

Os Innominatum is in young persons composed of three bones; the upper is named ilium, the lower and posterior os ischii, and the anterior os bubis: the upper edge of the ilium is called its spine, the anterior part of the spine its apex, and a little lower is the processes innominatus. Ilium has two processus, the one named the obtuse process, and the other the acute; in the centre of

these bones is the acetabulum or socket for the thigh bone; in the bottom of which socket is another cavity, in which lies the lubricating gland of this joint. When impostumations happen in this joint they usually cause a great swelling and lameness in the hip, which, in time, makes a collection of matter in the external part of the hip; however, this is not the only way it proceeds, for I have twice seen the matter in the joint make way through the bottom of the acetabulum into the pelvis of the abdomen; in these cases, when the patient went to stool, the matter, by straining, was pressed out through the external wound.

CHAPTER IV.

BONES OF THE UPPER LIMB.

CLAVICULA is connected at one end to the sternum with a loose cartilage, and at the other to the processus acromion of the scapula; its chief use is to keep the scapula a sufficient distance from the breast, by which means the shoulders are hindered from coming near together, as they do in those quadrupeds which use their fore limbs only to walk on, and not as men do their hands.

Scapula is fixed to the sternum by the clavicula, but its chief connection is to the ribs and

spine, by those muscles which are made also for its various motions; and in such quadrupeds as have no clavicles it is fixed only by muscles, whose actions give to this bone a great deal of that motion which seems to be in the joint of the shoulder. The under side of this bone is a little concave, partly to fit to the outer surface of the ribs on which it moves, and partly to give room for the sub-scapularis muscle. On the outside arises a large spine; the fore part of which is called the processus acromion, to which the clavicula is fixed. In men and such quadrupeds as have clavicles, and use their fore limbs like arms, this process and spine are much larger and more prominent, not only for the better fixing the clavicle, but also to remove the muscles farther from the centre of motion, whereby they are able to move a greater weight. Near this process is another called coracoides, from whose extremity, with like advantage, arise two muscles of the arm; this process with the former and a flat ligament between them both, hinder the os humeri from being dislocated upwards. The side opposite to the socket is called the basis of the scapula, and the lower edge costa inferior from its figure, which is thick, and like a rib to the scapula; but its upper edge being very thin, is improperly so called in the human skeleton, though not so in many quadrupeds. At the fore part of this edge, close to the coracoid process, is a semicircular nich for the passage of blood

vessels, which nich is joined at top with a ligament, and sometimes with bone.

Os humeri: its upper end or head, where it is joined to the scapula, is somewhat flat, and much larger than the socket which receives it. At the upper part are two processes for the insertions of muscles of the arms; between these processes is a long channel, in which lies a tendon of the biceps cubiti. At the lower end are two considerable processes, both formed to give origins to muscles of the wrist and fingers; and the flexors of these joints being much more considerable than the extensors, the inner process from which the flexors arise is therefore much larger than the outer, from which the extensors take their origins: between these processes is the joint. That part to which the upper end of the radius is fixed, is fitted not only for the motion of the elbow, but also for the rotatory motion of the radius; the rest of this joint is made of portions of unequal, but concentric circles, like the shanks of quadrupeds; which inequality prevents the ulna from dislocating sideways, which so small a joint with so much motion would be very subject to. Of a like use is the little sinus on the fore part of the humerus, and the large one behind; the first of which receives a process of the ulna when the arm is bent, and the other, the olecranon, when the arm is extended.

Ulna: at the upper end it has one large process called olecranon, and a small process on the

fore part ; and on one side between these is also a small cavity which receives the upper end of the radius for its rotatory motion ; and down the side of this bone, next the radius, is a sharp edge, from which the ligament arises, which connects those bones together. At the lower end is a process, called styliformis, and a round head, which is received into the radius for the rotatory motion of the cubit.

Radius : its upper end is received into the ulna, and joined to the humerus, in a manner chiefly fitted for its rotatory motion, for the strength of the elbow joint receives but little advantage from the union of these two bones. A little below this head is a large tubercle, into which the biceps muscle is inserted, which by the advantage of this insertion turns the cubit supine, as well as bends it. At the lower end, which is thicker, is a socket to receive the carpus, and at the side next the ulna a small one to receive that bone, and a thin edge, into which the transverse ligament, which arises from the ulna, is inserted. This ligament ties these bones conveniently and firmly together : for the ulna being chiefly articulated to the os humeri, and the radius to the carpus, a weight at the hand, without this ligament, would be liable to pull these bones asunder.

Of the bones of the hand : Carpus is composed of eight bones of very irregular forms, undoubtedly the properest that can be ; yet why in these

forms, rather than any other, no one has been able to shew. They have all obscure motions one with another, and with those of the metacarpus; but the motion of those of the first rank, or order, with those of the second is more considerable, and are moved by the same muscles which move the carpus on the radius. The metacarpus consists of four bones which sustain the fingers; that of the fore finger having the least motion, and that of the little one the most: the other ends of these bones have round heads for the articulations of the fingers; but the other joints of the fingers double heads and sockets. The thumb is shorter and stronger than any of the fingers, because in its actions it is to resist them all. The first joint is very singular, each bone receiving and being equally received. The bones of the fingers on the inside are flat and a little hollow, which is necessary to make room for the flexors of the fingers, and to render their shape proper for grasping; but this lessening their diameters, and consequently weakening them in the direction in which they are most liable to be broke, such inconvenience is provided against by a larger substance.

CHAPTER V.

BONES OF THE LOWER LIMB.

OS Femoris at its upper end has a round head which is received into the socket of the os innominatum. In most quadrupeds this head is oblong, and makes a firmer articulation; but that shape will not allow of so much motion as a rounder head. The two processes near the head are called the greater and lesser trochanters, which are evidently formed for the insertion of muscles, as the neck which lies between these and the head, is formed to make room for that necessary quantity of muscles which are seated on the inside of the thigh, and also by projecting outwards to make long levers for the muscles, which are inserted into its upper and external parts. Between the great trochanter and the neck is a large sinus, into which muscles are inserted: between the two trochanters is a remarkable roughness for the same use, from which begins the linea aspera. The middle of this bone, for the conveniency of the muscles, is bent forwards, which would make it subject to break backwards, if there was not a strong ridge on the back side, which strengthens it sufficiently, and serves also for advantageous insertions for several muscles; this ridge is called the linea aspera. At the lower end of this bone are two large heads,

called the outer and inner apophyses : these are so contrived, partly from being projected backwards, and partly from their shapes, as to remove the centre of motion very far behind the axis of the bone, which gives great power to the muscles that extend this joint to raise the whole weight of the body, though it lessens the power of the benders which move the leg only ; between these processes the large vessels descend securely to the leg.

Patella is seated on the fore part of the knee ; its first appearance is in the centre of the tendon, through which it soon extends, until the tendinous fibres are lost, and appear to be converted into bone ; however, when this bone is broke, the original tendinous fibres seem to prevail, seeing the broken parts, unlike all other bones when fractured, unite with a tendon-like substance, which is rarely converted into bone, and especially in those cases where the joint recovers with most motion ; its use is to secure the extensors of the tibia, lest, passing over the joint, they might be too much exposed to external injuries ; it also increases the advantage (mentioned in the last paragraph) of removing the common axis of the extensors of the tibia farther from the centre of motion, and is a most convenient medium for those muscles to unite in, to perform one common action.

Tibia, the shin bone, is large at its upper end, where are too shallow sockets which receive the thigh bone ; between these is a rough process, to

which the cross ligaments of this joint are connected. Near the upper end is a process, into which the ligament or tendon of the patella is inserted, and at the lower end is the process, which makes the inner ancle, and secures this bone from dislocating outwards. Towards the upper end this bone is triangular, and even concave on the side next the muscles to make room for them; but lower, as the muscles grow less and tendinous, the bone grows rounder; that being upon the whole a stronger form; yet it is not made so strong as the thigh bone, though it bears a greater weight, which it is able to do by being straighter, shorter, and bearing the weight of the body in a more perpendicular direction.

Fibula is seated on the outside of the tibia; its upper end is joined to that bone below the joint of the knee, and its lower end is received into a shallow sinus of the same bone, and below that makes the external ancle; which process, with the process of the tibia, strengthens the ancle joint, which nevertheless, being so small, would have been not strong enough, if it had been made for more motion. It is doubtful to me, whether or not this bone contributes to the support of the body; but its great use is for the origins of muscles, and even its shape is suited to theirs.

Of the bones of the foot: Tarsus is composed of seven bones, the first of which, called astragalus, supports the tibia, and is supported by the os

calcis, which being projected backwards, makes a long lever for the muscles to act with, that extend the ancle and raise the body upon the toes. These two bones have a considerable motion between themselves, and the astragalus also with the os naviculare, and all the rest an obscure motion one with another,and with the bones of the metatarsus, the greatest part of these motions being towards the great toe, where is the greatest stress of action: these bones thus giving way are less liable to be broke, and, as a spring under the leg, make the motions of the body in walking more easy and graceful, and the bones which are supported by them less subject to be fractured in violent actions. To these join five others, called the metatarsal bones; that which supports the great toe is much the largest, there being the greatest stress in walking; under the end of this lie the two sesamoid bones, which are of the same use as the patellá; the great toe has two bones, the lesser three each, the two last of the least toes frequently grow together.

Children are sometimes born with their feet turned inwards, so that the bottom of the foot is upwards: in this case the bones of the tarsus, like the vertebræ of the back in crooked persons, are fashioned to the deformity. The first knowledge I had of a cure of this disease was from Mr. Presgrove, a professed bone-setter, then living in Westminster. I recommended the patient to him, not knowing how to cure him myself. His way was

by holding the foot as near the natural posture as he could, and then rolling it up with straps of sticking plaster, which he repeated from time to time, as he saw occasion, until the limb was restored to a natural position, but not without some imperfection, the bandage wasting the leg, and making the top of the foot swell and grow larger. After this, having another case of this kind under my care, I thought of a much better bandage, which I had learnt from Mr. Cowper, a bone-setter at Leicester, who set and cured a fracture of my own cubit when I was a boy at school. His way was, after putting the limb in a proper posture, to wrap it up in rags dipped in the whites of eggs, and a little wheat flower mixed; this drying, grew stiff, and kept the limb in a good posture. And I think there is no way better than this in fractures, for it preserves the position of the limb without strict bandage, which is the common cause of mischief in fractures. When I used this method to the crooked foot, I wrapt up the limb almost from the knee to the toes, and caused the limb to be held in the best posture till the bandage grew stiff, and repeated the bandage once a fortnight.

The bones are subject to diseases from all the same causes that the other parts are, but either from their hardness, insensibility, or other causes, they neither are so frequently diseased, nor do their diseases appear so various; and it is generally of more consequence what texture the diseased bone, or part

of the bone is of, than from what cause that disease proceeded; for when diseases happen upon the surfaces of the hard bones, they usually admit a cure by exfoliation; but when matter is made in the spongy ends of the cylindrical bones, or in the bodies of other spongy bones, the matter, whatever was the first cause, insinuates itself through those spongy cells, swelling the bone, and making generally an incurable caries; but if the matter is corrosive, it often ulcerates these parts; and usually makes so large a discharge as to destroy the patient where the part diseased cannot be extirpated, which is often the case when matter is made in the bones in scrophulous habits.

The venereal disease rarely attacks any but the hardest parts of the bones, very soon raising large tumours and caries or mortification; but these carious parts of bones from this or other causes are but partially mortified; for, were they perfectly so, the sound and unsound parts would separate, though the integuments were not taken off; whence it happens, that, where there is a good habit of body, carious bones are often endured many years without much inconvenience; and we find from experience, that such separations are not to be made till the diseased part is laid bare and perfectly mortified by being exposed to the air, &c. and then the sound part underneath separating from the unsound, there first granulates a fungous flesh-like appearance, which ought never to be treated with cor-

rosive medicines, it constantly shrinking and hardening of itself, being the same substance which shoots from the ends of broken bones, where also it soon shrinks and converts into a callus to reunite them.

There is a caries distinct from these, which I have only seen in two patients who died after a long rheumatic disorder, in which the outer surface of all the hardest bones, as the middle of the cylindrical bones, and the top of the scull, in one which I boiled, and in the other as far as I was allowed to examine, I found the outer part every where crumbly or scaly, falling into pieces like dust or sand, with very little appearance of tumour any where, and no appearance of disease in the spongy parts.

Sometimes matter is formed in the large medullary cavities of the cylindrical bones, which constantly increasing and wanting vent, partly by corroding and rendering the bone carious, and partly by pressure, tear asunder the strongest bone in an human body, of which I have known several instances. In one case where the matter had sufficient discharge by an external caries formed together with the internal one, all the internal hard part of the bone which contains the medulla was separated from the rest; and being drawn out through the place where the external caries made a vent, the patient received a perfect cure. In another case of this kind, where the internal part which contains the medulla was also separated from the reſt, and

there being holes through which the matter was discharged, but none sufficient to take out the exfoliated bone; the matter continued to flow in great quantity till it destroyed the patient; and possibly, if this case had been rightly known, the internal exfoliated part might have been taken out, and the patient cured. In both these cases, it seems as if only so much of the internal part of the bone was become carious, as receives nourishment from the artery which enters the middle of the bone; and as a caries is a mortification of a bone, might not this disease arise from a hurt in the vessel which nourishes that particular part?

CHAPTER VI.

CARTILAGES, LIGAMENTS, &c.

EVERY part of a bone which is articulated to another bone for motion, is covered or lined with a cartilage, as far as it moves upon, or is moved upon by another bone in any action; for cartilage being smoother and softer than bone, it renders the motions more easy than they would have been, and prevents the bones wearing each other in their actions.

In each articulation of the lower jaw, there is a loose cartilage, upon which the condyloid process moves on one side, while the jaw is moved to the

other; and the two processes being thus raised at once; the jaw is thrust forward. These cartilages are also found in animals that chew the cud, but not in beasts of prey, as far as I have examined, their articulations being also deeper and firmer; and in the otter particularly, sections of the sockets, which receive the condyloid processes of the lower jaw, are more than half circles; so that the jaw cannot be dislocated directly without breaking the sockets. This structure renders the motions of the jaw more firm, as that with intervening cartilages makes it more loose and voluble. There are also cartilages of this kind between the clavicles and the sternum.

In the joint of the knee are two loose, almost annular cartilages, which being thick at their outer edges, and thin at their inner ones, they make the greatest parts of the two sockets in this joint. The use of these cartilages is to make variable sockets to suit the different parts of the lower end of the os femoris; for none but a round head and a round cavity can suit in motion, unless the shape of one or the other alters: and it is plainly necessary, that this lower end of the os femoris should be flattish, and projected backward, to give advantage to the muscles that extend the tibia, by setting the centre of motion backward: which mechanism, though it equally lessens the power of those muscles which bend this joint, is yet of great service, because the extending muscles move this joint under the weight

of the whole body, but the flexors only raise the legs; and as no head or socket moves so easily as round ones, here seems to be some provision made against the inconvenience of a flattish head and cavity, by having the friction made upon two surfaces, the os femoris upon the loose cartilages, and the loose cartilages upon the tibia. This contrivance is practised by mechanics, where the friction of the joints of any of their machines is great, as between the parts of hook-hinges of heavy gates, and between the male and female screws of large vices, where they usually place a loose ring.

There are other cartilages which serve to give shape to parts. Of this sort are the ciliary cartilages at the edge of the eye-lids, the cartilages of the outer ears, and those which compose the lower part of the nose, which have this particular advantage in these places, that they support and shape the parts as well as bones do, and without being liable to be broke; and to these might be added those of the larynx, but they do not belong properly to the skeleton.

Bones that are articulated for motion are tied together by very strong ligaments, to prevent their dislocating, which also surround the joints to contain their lubricating mucus. The thickness and strength of these ligaments are proportioned to the actions of the several joints, and their lengths are no more than sufficient to allow a proper quantity of motion; but the forms of

them are different according to the different actions of the several joints.

The bones of the limbs that move to all sides have ligaments like purses, which arise from or near the edges of the sockets of the receiving bones, and are inserted all round the received bones a little below their heads. The beginnings of these ligaments, from the edges of the sockets of the scapula and os innominatum, are very hard, almost cartilaginous, which serves in the scapula to make a larger socket, and such an one as will alter the figure as the bone moves, for the reason I have mentioned in the loose cartilage of the knee: for the head of the os humeri, not being an exact portion of a sphere, requires such a socket, and the hard part of this ligament of the socket of the os innominatum, makes the socket deeper than the semidiameter of the socket, by which means the articulation is made stronger without any hindrance to motion, because it will give way to the neck of the os femoris when it presses against it; and the thigh bone being more disposed to be dislocated upwards than any other way, the upper side of this burſal ligament is made exceeding ſtrong to prevent ſuch an accident. From the lower edge of the acetabulum or ſocket of the os innominatum ariſes a ligament about an inch long, called teres, or rotundum, which length is necessary for that quantity of motion which this joint has in human bodies; it also hinders the os femoris from dislocating upwards, but downwards

it will suffer it to go far out of the socket; but in brutes the head of the os femoris being oblong, and the cavity suitable, there can be only a rotatory motion, which in effect will be very little more than that kind of motion which is called bending and extending; and this never removing the end of the head of the bone far in the socket, a short ligament is enough for it, and will better keep the bone in its place; and therefore it is that theirs is so short. This ligament in men may also serve to press the gland in the bottom of the acetabulum or socket.

The ligaments of those joints which admit only of flexion and extension, differ from the former in this, that they are much shorter and stronger at the sides of the joints, and thinner backward and forward. Besides these ligaments, in the middle and back part of the joint of the knee, are two very strong ligaments, which arise from a process at the end of the tibia. They cross each other in such a manner, as is best to secure the joint from being displaced any way; they also hinder the extensors of the tibia from pulling that bone too far forwards, and are so connected to the semilunar cartilages, as to move them as the joint moves; besides these, in this joint is another small one, which arises from the os femoris, and ends in the fatty membrane which it supports. The knee, I think, cannot be completely dislocated without breaking the cross ligaments: I have seen this case but once,

the bone indeed was easily restored to its place, but to no purpose.

The bones of the carpus and tarsus are tied together by ligaments running promiscuously upon their surfaces from one to another ; which at the under side of the tarsus are vastly strong, because they support the whole body ; these ligaments together contain the mucus for all those joints. There is also to the carpus a strong ligament, which runs from the fifth bone to the eighth, and the process of the fourth bone : the proper use of this is, to bind down the tendons of the muscles that bend the fingers.

The processus dentanus of the second vertebra is tied to the scull by a ligament, and kept close to the forepart of the first vertebra by another in that vertebra, that it may not bruise the spinal marrow ; and when either this ligament or process is broke, it makes that sort of broken neck which is attended with sudden death. All the bones of the vertebræ, and every joint that is without motion, and not joined by a suture, as the ossa innominata with each other, and the os sacrum with the ossa innominata, are joined by intervening ligaments, or, as they are commonly called, cartilages. The ossa innominata are also tied by very strong ligaments which run from the back parts of the spines of the ossa ilia to the os sacrum, and other ligaments which go from the os sacrum, and os coccygis to the acute and obtuse processes of the ossa is-

chia: these ligaments serve also for origins of muscles. Towards the great foramen of the ossa innominata the acetabulum has a deep notch, from the one side to the other of which runs a ligament which completes the socket; this ligament is sometime ossified: a ligament somewhat like this there is between the processes of the scapula.

From the edge of the ilium to that of the os pubis, runs a ligament which is contiguous to, and appears to be a part of, the tendons of the muscles of the abdomen; its use is to cover the iliac vessels as they descend to the thigh. Under this ligament, together with the vessels, I have often seen a rupture of matter, and, I think, sometimes of the gut, from the abdomen into the anterior part of the thigh, immediately below the groin: however, I dare affirm this to be a possible case.

It is generally agreed, that the ligaments are insensible, and the reason assigned is, that they would else be injured by ordinary motions. But they are much better contrived; seeing none of them, not even those which lie between the vertebræ, are subject to attrition; but the other, experience shews, are capable of very acute pains; there being not any thing our patients more grievously complain of, than collections of matter within these parts, or sharp medicines applied to them, when laid bare.

Every joint, where the bones are faced with a cartilage for a sliding motion, is furnished with small glands, which separate a mucilaginous mat-

ter for the lubricating of the ends of the bones, that they may move easily upon one another; and that there may be no waste of this necessary fluid, it is contained in the investing ligaments; which for this very reason, are no where divided, except to communicate with the ligaments of the tendons.

These glands are generally seated in a little fat near the insertion of the ligaments, that they may be compressed by them when the joints are in motion; which is a proper time to have their fluid pressed out. The most considerable parcel of these glands, with their fat, are seen in the joint of the knee, and the largest gland of this sort is found in the sinus at the bottom of the acetabulum of the os innominatum, and is compressed by the ligamentum teres.

The diseases of the joints either happen from ulcers in the lubricating glands, which, pouring out matter that cannot be discharged, foul the ends of the bones, or else from swellings in the ends of the respective bones. Either of these in time create excessive pain, which appears to me to be chiefly in the ligaments of the joints, notwithstanding what has been said of the insensibility of these parts. When a joint is much swelled and painful, without external inflammation, it is vulgarly called a white swelling, and more properly so than spina ventosa. It is sometimes in the beginning cured by evacuations, but when the limb wastes below the swelling, and the fingers or toes of the limb

grow thinner at their joints, and lose their shape, the case then is absolutely irrecoverable. Sometimes the ends of the bones erode, then join together and form an anchylosis, which, though a severe disease of itself, yet it is often a remedy of one that is much worse. In like manner the bones of the hands and feet, when they are ulcerated, sometimes unite, and are thus preserved from total ruin. But there is one case of a white swelling that is amazing, where the pain is so great that we are forced to take off the limb, and yet neither find upon dissection the ligaments or glands diseased, nor matter in the joint, nor the bones carious, or any diseased appearance, except that the ends of the bones are a little larger and softer.

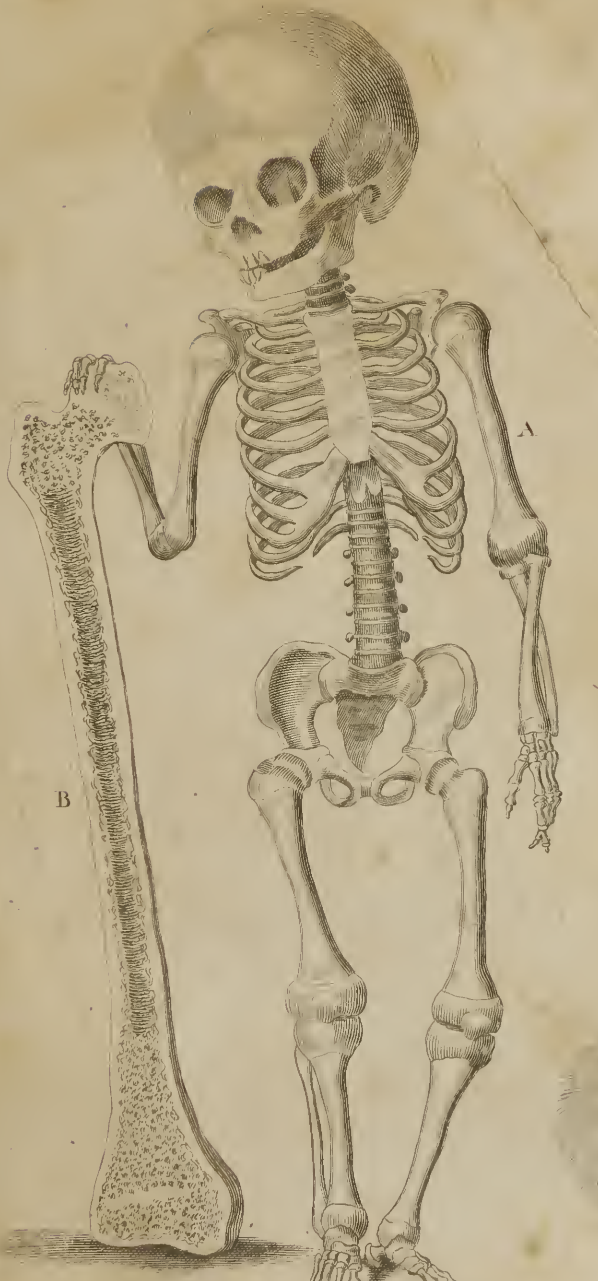
TABLE I.

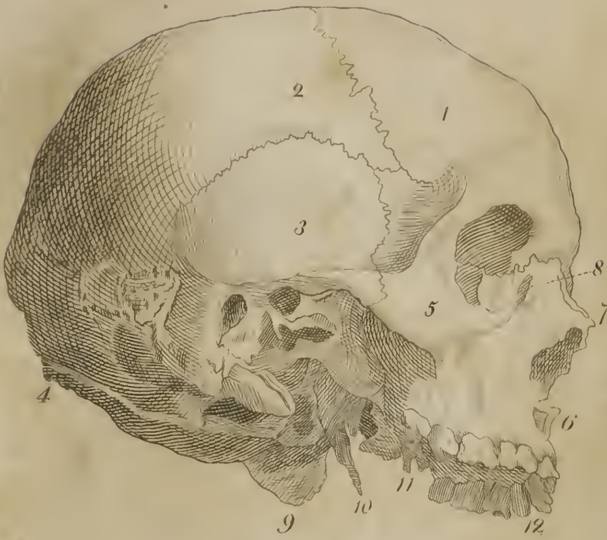
A, The skeleton of a child twenty months old, in which all the bones differ in shape from those of an adult. The scull is much larger in proportion, and the bones of the limbs without those roughnesses and unevennesses which afterwards appear; their texture is every where more loose and spongy, and their outlines what the painters call tame and insipid; their extremities are separate and formed cartilaginous, which is accurately distinguished in the plates by the manner of graving.

B, The thigh bone of a man, sawed through, in the middle of which is seen the cavity which contains the oily marrow, and at the extremities the lesser cells, which contain the bloody marrow. The white line across the head of this bone, beginning at the fingers of the skeleton, is the place where the epiphysis and the bone are united. A like line, across the lower end of this bone, shews there the same thing.

C, The os bregmatis of a fœtus six months old, which shews the fibres ossifying from the centre to the circumference.

TAB I.

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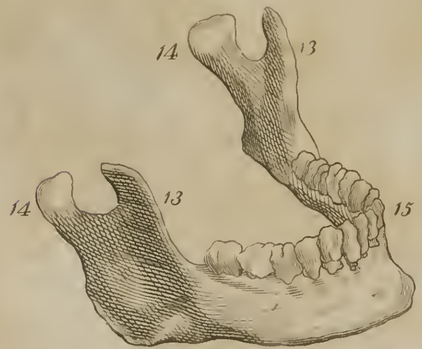
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TABLE II.

1 Os frontis.
2 Os bregmatis.
3 Os temporis.
4 Os occipitis.
5 Os malæ.
6 Os maxillæ superioris.
7 Os nasi.
8 Os planum.
9 Processus mastoideus.
10 Processus styloides.
11 Processus pterygoides.
12 Dentes.
13 Processus coronalis.
14 Processus condyloides.
15 Dentes.

TABLE III.

1 Os frontis.
2 Os bregmatis.
3 Os occipitis.
4 Sella turcica.
5 A process of the os sphenoides, making part of the septum nasi.
6 A process of the os ethmoides, making part of the septum nasi.
7 Vomer.
8 Crista galli, before which is seen in shadow the sinus frontalis.
9 The cornua of the os sphenoides.
10 Sella turcica.
11 Os frontis.
12 Crista galli and os ethmoides.
13 Sinus frontales,
14 Sella turcica.
15 The fifth foramen.
16 Processus jugales.
17 Os petrosum.
18 Foramen magnum.
19 The outside of the os occipitis.


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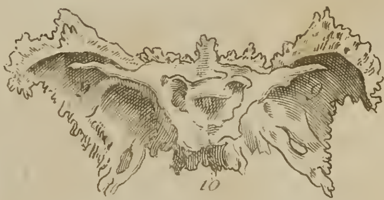
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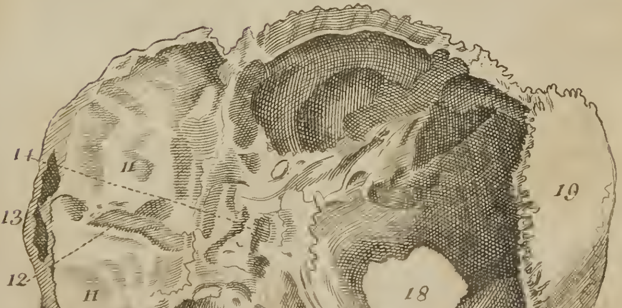
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TAB.IV.

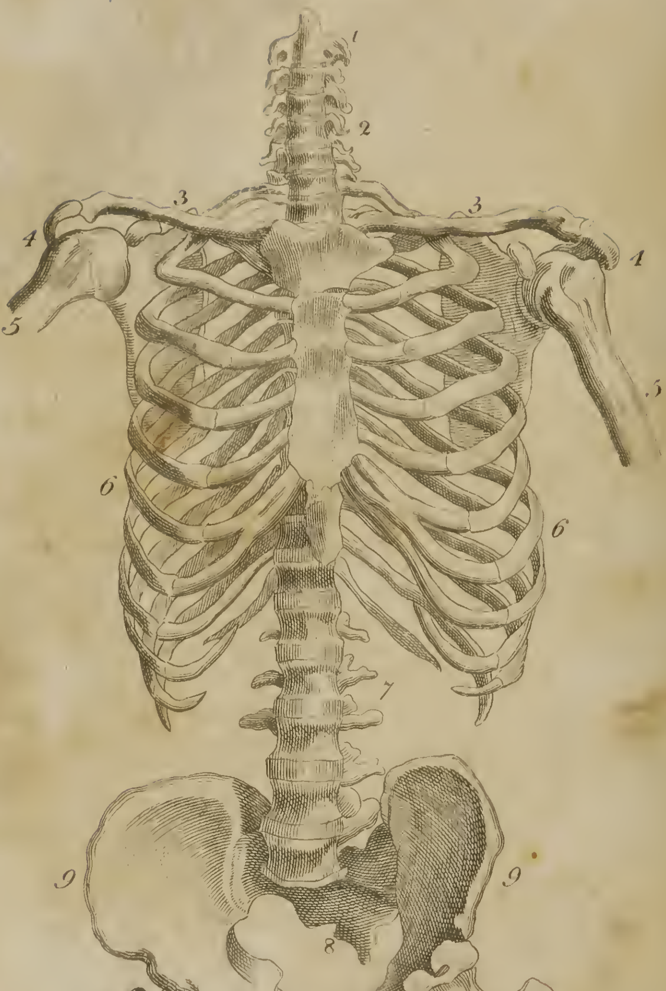

TABLE IV.

1 The second vertebra of the neck.
2 The transverse processes of the vertebræ of the neck.
3 Clavicula.
4 The processus acromion of the scapula.
5 Os humeri.
6 The ribs.
7 The transverse processes of the vertebræ of the loins.
8 The os sacrum and os coccygis.
9 Os ilium.
10 Os ischium.
11 Os pubis.
12 Os femoris.

TABLE V.

1 The under side of the first vertebra of the neck.
2 A side view of the second vertebra.
3 The processus dentatus of the second vertebra.
4 The under side of the oblique process.
5 The spinal process.
6 The under side of the body of the seventh vertebra of the neck.
7 The transverse processes.
8 The oblique processes.
9 The spinal process.
10 The spinal process of the second vertebra of the back.
11 The under and fore side of the body of the vertebra.
12 The transverse processes.
13 The upper oblique processes of the third vertebra of the back.
14 The transverse processes.
15 The spinal process.
16 The body of the third vertebra of the loins.
17 The transverse processes.
18 The upper oblique processes.
19 The spinal process.

TAB V.

TAB. VI.

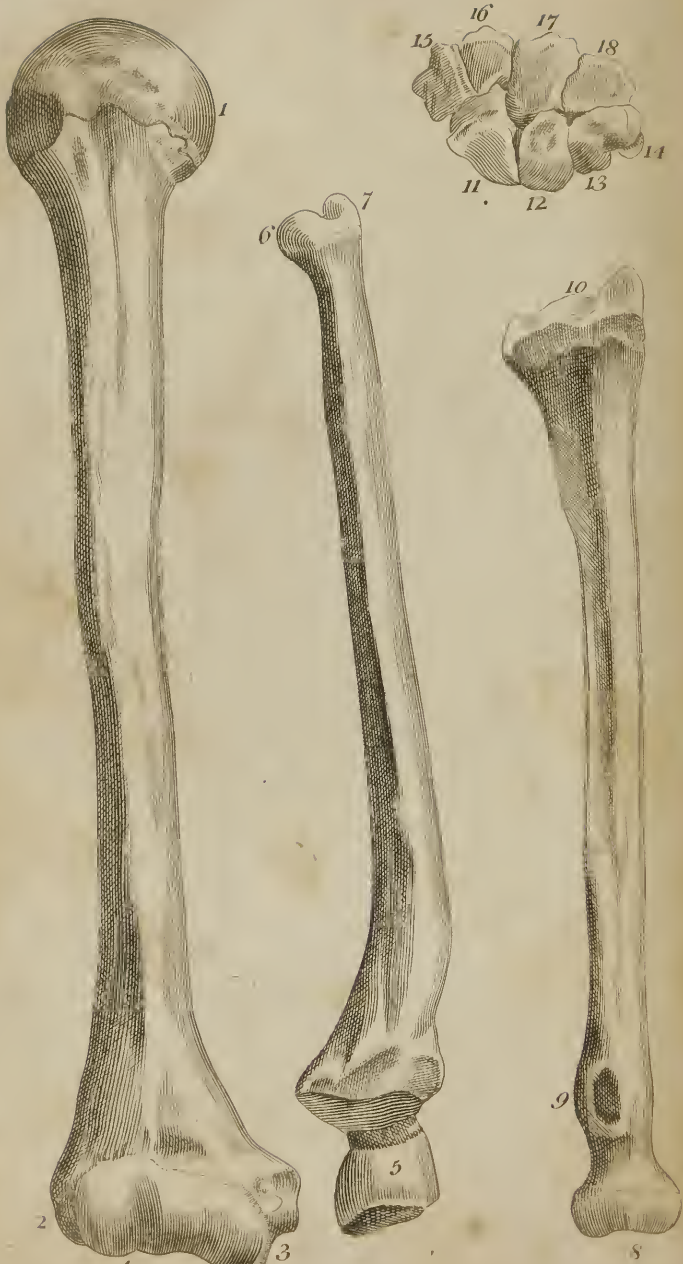

TABLE VI.

1 The head of the os humeri.
2 The outer extuberance.
3 The inner extuberance.
4 That part which joins with the ulna.
5 The olecranon of the ulna.
6 The lower end of the ulna which joins to the radius.
7 Processus styloides.
8 The upper end of the radius.
9 The tubercle.
10 The part of the radius which joins with the carpus.
11, 12, 13, 14, 15, 16, 17, 18, The eight bones of the carpus.

TABLE VII.

1 Radius.
2 Ulna.
3 Carpus.
4 The three bones of the thumb.
5 The four bones of the metacarpus.
6 The three bones of the fingers.

TAB. VII.

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TABLE VIII.

1 The head of the os femoris.
2 The great trochanter.
3 The lesser trochanter.
4 The lower end which articulates with the tibia.
5 The upper end of the tibia.
6 The lower end of the tibia.
7 The process which makes the inner ancle.
8 The upper end of the fibula.
9 The lower end which makes the outer ancle.
10 The outside of the patella.
11 The inside of the patella.

TABLE IX.

1 Astragalus.
2 Os calcis.
3 Os naviculare.
4, 5, 6, Ossa cuneiformia.
7 Os cuboides.
8 The five bones of the metatarsus.
9 The two bones of the great toe.
10 The three bones of the lesser toes.


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TAB.X.

TABLE X.

A skeleton of an adult put into this posture to shew it in a greater scale. It was thought better not to figure it, all these bones being explained in former plates, and the design of this being to shew them together, without being defaced with references.

THE

ANATOMY

OF THE

HUMAN BODY.

BOOK II.

CHAPTER I.

INTRODUCTION TO THE MUSCLES.

THE muscles are moving powers, applied to perform the several motions of the body; which they do by contracting their length, and thereby bringing the parts to which they are fixed nearer together. The immoveable or least moved part any muscle is fixed to, is usually called its origin, and the other its insertion; but muscles that have their two ends equally liable to be moved, may have either called the origins or insertions.

Each muscle is made up of a number of small fibres, which BORELLI and others have thought

to be strings of bladders, and have endeavoured to account for muscular motion by an expansion made from an influx of blood and animal spirits into these bladders; but as the muscles do not increase their bulk sensibly in contracting, there needs no more to be said to refute this hypothesis. But another great author thought that in this way the muscles might be contracted by a swelling, scarce sensible, if the bladders were but very small: for, says he, supposing a bladder of any determined bigness can raise a weight a foot, a hundred bladders, whose diameters are each a hundredth part of the former, will raise the weight to the same height. But the force of inflation and the swelling of all together will be ten thousand times less, and it will also raise ten thousand times less weight, which he has not observed; therefore not one such string of bladders, but ten thousand, must be applied to do the same thing that the one bladder will do; and they will have the same swelling; otherwise it would be easy to shew how to make a perpetuum mobile of almost any force.

The muscles are of two sorts, viz. rectilineal, and penniform. The former have their fibres almost parallel, in the same or near the same direction with the axis of the muscle; and the latter have their fibres joined, in an oblique direction, to a tendon passing in or near the axis, or on their outside.

The rectilineal muscles, if their origins and insertions are in little compass, are never of any con-

siderable thickness, unless they are very long, because the outer fibres would compress the inner ones, and make them almost useless; and therefore every rectilineal muscle, whose inner fibres are compressed by the outer, have their inner fibres longer than the external, that they may be capable of equal quantity of contraction.

The penniform muscles, though they are in a manner free from the inconvenience of one fibre compressing another, and though by the obliquity of their fibres, nothing is abated of their moment, (for in all cases, just so much more weight as rectilineal fibres will raise than oblique ones, the oblique will move their weight with so much greater velocity than the rectilineal; which is making their moments equal: so that in the structure of an animal, like all mechanic engines, whatever is gained in strength is lost in velocity, and whatever is gained in velocity is lost in strength) yet the fibres of the penniform muscles becoming more and more oblique as they contract, their strength decreases, and their velocity increases, which makes them less uniform in their actions than the rectilineal muscles; wherefore it seems that nature never uses a penniform muscle where a rectilineal muscle can be used; and the cases in which a rectilineal muscle cannot be used, are where the shape of a muscle is such as that the inward fibres would be too much compressed, or where rectilineal fibres could

not have a lever to act with, suitable to their quantity of contraction, which is the case of all the long muscles of the fingers and toes. For every muscle must be inserted or pass over the centre of motion of the joint it moves, at a distance, suitable to its quantity of contraction, and the quantity of motion in the joint moved; for if it was inserted too near, then the motion of the joint would be performed before the muscle is contracted all that it can; if too far off, the muscle will have done contracting before the whole motion of the joint is made. And though the quickness and quantity of motion in a muscle will be, cæteris paribus, as the length of its fibres; (for if a fibre four inches long will contract one inch in a given time, a fibre eight inches long will contract two inches in the same time; and the strength of a muscle or power to raise a weight, cæteris paribus, will be as the number of its fibres; for if one fibre will raise a grain weight, twenty fibres will raise twenty grains :) nevertheless, two muscles of equal magnitude, one long, and the other short, will both move the same weight with the same velocity when applied to a bone; because the levers they act with must be as their lengths, and therefore the penniform and short thick muscles are never applied to a bone for the sake of strength, nor long fibred muscles for quickness; for whatever is gained by the form of the muscle, whether strength or quickness, must be lost by their insertions into

the bone, or else the muscles must not act all they can, or the bones have less motion than they are made for.

In the limbs several muscles pass over two joints, both of which are liable to move at once, with force proportionable to the levers they act with upon each joint; but either joint being fixed by an antagonist muscle, the whole force of such muscles will be exerted upon the other joint; which in that case may be moved with a velocity equal to what is in both joints, when these muscles act upon both at once. This mechanism is of great use in the limbs, as I shall shew in the proper places.

That only we call the proper use and action of any muscle which it has without the necessary assistance of any other muscle, and what that is in a muscle moving a joint we may always know in any situation, and with what force it acts, cæteris paribus, by dropping a line, from the centre of motion of the joint it moves, perpendicular into the axis of the muscle; but in a joint which admits only of flection and extension, this line must also be perpendicular to the axis of motion in that joint, and the action of the muscles will be in the direction of that perpendicular line, and the force with which it acts in any situation will be, cæteris paribus, as the length of that perpendicular line.

Each muscle, so far as it is distinct, and is moved against any part, is covered with a smooth mem-

brane to make the friction easy ; but where they are externally tendinous, those tendons are often smooth enough to make such a covering needless. Besides this membrane there is another, known by the name of fascia tendinosa, which deserves to be particularly considered. The strong one on the outside of the thigh, which belongs to the fascialis and gluteus muscles, is of great use in raising the gluteous farther from the centre of motion of the joint it moves, to increase its force : in like manner the fascia detached from the tendon of the biceps cubiti alters its directions for the same purpose, but those on the outside of the tibia and cubit, &c. are only flat tendons from which the fibres of the muscles arise as from the bones. There are also in many places such tendons between the muscles, from which each muscle arises in like manner ; for the bones themselves are not sufficient to give origin to half the fibres of the muscles that belong to them ; besides, if all the fibres had rise from the bones, they must have been liable to compress one another very inconveniently.

CHAPTER II.

OF THE MUSCLES.

OBLIQUUS descendens arises fleshly from near the extremities of the eight inferior ribs, the upper part of its origin being indented with the seratus major anticus, and the lower lying under a small portion of the latissimus dorsi. It is inserted fleshly into the upper part of the spine of the ilium, and by a broad flat tendon, (which firmly adheres to a like tendon of the following muscle as they pass over the rectus) into the os pubis, and linea alba, which is a strong tendinous line extended from the os pubis to the sternum, between the musculi recti.

Obliquus ascendens arises fleshly under the former muscle from the spine of the ilium, and is inserted fleshly in the cartilages of the three lowest ribs, and by a flat tendon into the sternum, and linea alba, together with the tendon of the foregoing muscle. The line in which these two tendons join on the outside of the rectus muscle, is called semilunaris: and though so much of this muscle as is inserted fleshly runs obliquely upward, yet the middle and lower part is directed transverse and downward; and beside the tendon, which it unites with the obliquus descendens, it often detaches another near the sternum to be inserted with the transversalis under the rectus.

Pyramidalis arises from the os pubis, and is inserted into the linea alba, about three or four inches below the navel: this and its fellow are often wanting.

Rectus arises tendinous from the os pubis, but fleshy when the pyramidales are wanting, and is inserted into the lower part of the sternum, near the cartilago ensiformis. This muscle is divided into four or five portions by transverse tendinous intersections, that it might conveniently bend when the body is bowed forwards, though this muscle should be then in action; and these intersections are chiefly above the navel, where it is most liable to be bent: besides, being thus divided, its chief pressure will not be in its middle, but under the several bellies of the muscle, and the greatest below the navel, where is the longest fleshy belly of this muscle, and where the parts in the abdomen seem to want most to be supported.

Transversalis arises by a flat tendon from the transverse processes of the lumbal vertebræ, and fleshy from the inside of the ribs below the diaphragm, and from the spine of the ilium; then, becoming a flat tendon, it passes under the rectus to its insertion into the linea alba. Between this tendon and the peritoneum sometimes water is found in great quantities, which distemper is called the dropsy in the duplicature of the peritoneum; which shews this membrane has been mistaken for part of the peritoneum.

These five pair of muscles all conspire to compress the parts contained in the abdomen. The obliquus descendens on the right side, and ascendens on the left acting together, turn the upper part of the trunk of the body towards the left, and vice versa; but the trunk is chiefly turned upon the thighs; the recti bend the body forward, and pull the sternum downward in expiration; the two oblique muscles and the transverse on each side near the groin, are perforated to let through the processus vaginalis with the spermatic vessels. These perforations are distant from each other, so as to suffer the vessels to descend conveniently into the scrotum: this way the intestines or the omentum descend in ruptures.

Cremaster testis is a small portion of fibres which arises from the ilium, and appears to be part of the obliquus ascendens muscle, till it meets with the spermatic vessels at their coming out of the abdomen, where it begins to descend with them by the side of the processus vaginalis, to the testicle, over which it is loosely expanded. This muscle is too small to be plainly discovered in emaciated bodies.

Erector penis arises from the os ischium, and is inserted into the crus penis near the os pubis. It is said, by pressing the penis against the os pubis to compress the vena ipsius penis, and hinder the reflux of blood, whereby the penis becomes ex-

tended and erect: but it does not appear to me to be well contrived for that use.

Accelerator urinæ. This, with its fellow, are but one muscle. It arises tendinous from the ossa ischia, and fleshy from the sphincter ani; or, according to Mr. COWPER, from the superior part of the urethra as it passes under the os pubis: and thence being expanded over the bulb of the urethra, it afterwards divides, and is inserted into the penis. The use of this muscle is not to accelerate the urine, for that is propelled by the detrusor urinæ, or muscular coat of the bladder, but to protrude the semen, which is done only by this: and it being seated opposite to the os pubis, it seems to be much better fitted to be a relaxer of the penis, by pulling it from the os pubis, than the erector is for the office assigned it.

Transversalis penis is that part of the former muscle which arises from the ossa ischia.

Sphincter vesicæ urinariæ is a small portion of muscular fibres, not easily to be distinguished, running round the neck of the bladder to prevent the involuntary effusion of urine.

Detrusor urinæ is the muscular coat of the bladder; its fibres are differently disposed; but chiefly terminating in the sphincter vesica, whereby it not only presses the urine forward, but, when the bladder is full, becomes an antagonist to the sphincter, acting almost at right angles.

Erector clitoridis arises from the ischium, and is inserted into the crus clitoridis, like the erector penis in men, and is said to cause erection in the same manner.

Sphincter vaginæ is an order of muscular fibres, intermixed with membranous fibres, surrounding the vagina uteri near its orifice; it is connected to the ossa pubis and sphincter ani; its use is to constringe the orifice of the vaginâ, to press out a liquor from the glands of the vagina, and embrace the penis in coition.

Dr. DOUGLAS mentions two pair of muscles of the vagina, of his own discovering, which I have never dissected, and will therefore give them in his own words; "The first arises from the inner edge of the os pubis midway between the ischion and the beginning of the crus clitoridis, is inserted into the vagina; the second arises tendinous and fleshy from the os pubis internally in common with the levator ani, is inserted into the upper part of the vagina at the side of the meatus urinarius or collum vesica."

Sphincter ani is a muscle near two inches in breadth, surrounding the anus to close it, and to prevent involuntary falling out of the fæces.

Levator ani, by Dr. DOUGLAS called two pair of muscles, but Mr. COWPER describes the whole as one muscle only, which arises from the ossa ischii, pubis, and sacrum within the pelvis, and is inserted round the lower end of the rectum intestinum.

Fistulæ in ano, that are within this muscle, generally run in the direction of the gut, and may be laid open into the gut with great safety; but those fistulæ, or rather abscesses, that are frequently formed on the outside of the sphincter, and usually surround it, all but where this muscle is connected to the penis, cannot be opened far into the gut, without totally dividing the sphincter, which, authors say, renders the sphincter ever after incapable of retaining the excrement. One instance of this kind I have known; but Mr. BERBECK of York, an excellent surgeon, and particularly famous for this operation, has assured me, that he has often been forced to divide the sphincter, which has made the patients unable to hold their excrements during their cure, but the wounds being healed, they have retained them as well as ever.

Coccygei arise from the acute processes of the ossa ischii, and are inserted into the os coccygis, which they pull forward.

Occipito-frontalis, is a muscle with four fleshy bellies, commonly named frontales and occipitales. It arises behind each ear from the os occipitis, and soon becoming tendinous, passes under the hairy scalp to the forehead, where it becomes broad and fleshy, adhering to the skin, and is inserted into the upper part of the orbicular muscles of the eyelids, into the os frontis near the nose, and by two processes into the bones of the nose. When this muscle acts from the back part it pulls the

skin of the forehead upward, and wrinkles it transverse, and in some persons the hairy scalp backwards; but when the fore part of it acts, it draws the skin with the eyebrows downward, and towards the nose when we frown. The tendon of this muscle has been mistaken for a membrane, and been called pericranium, and the true pericranium, periosteum.

Elevator auriculæ arises from the tendon of the occipito-frontalis, and is inserted into the upper part of the ear that is connected to the head.

Retractor auriculæ arises by one, two, or three small portions from the temporal bone above the mammillary process, and is inserted into the ear to pull it backward.

Orbicularis palpebrarum surrounds the eyelids on the edge of the orbit, and is fixed to the sutura transversalis at the great corner of the eye; it ſhuts the eyelids, especially in winking. That part of this muscle that lies under the eyebrow is very much intermixed with the occipito-frontalis; and under it, from the os frontis near the nose, arises a small portion of distinct fibres which end in this muscle, and, I think, are a part of it; nevertheless, from the effect of their action, are not improperly called musculus corrugator.

Ciliaris is a very small portion of this muscle, next the ciliary cartilages of the eyelids.

Elevator palpebræ superioris rectus rises above the optic nerve, from the periosteum at the bottom of the orbit, as do also the five following muscles, and is inserted into the whole ciliary cartilage of the upper eyelid by a very thin flat tendon.

Elevator oculi arises from the bottom of the orbit, between the optic nerve and the foregoing muscle, and is inserted in the upper part of the tunica sclerotis of the eye, near the cornea.

Depressor oculi arises, and is inserted directly opposite the last described muscle.

Adductor oculi arises from the bottom of the orbit, near the optic nerve internally, and is inserted into the tunica sclerotis on the side next the nose.

Abductor oculi has both its origin and insertion directly opposite to the adductor.

Obliquus superior seu trochlearis arises between the elevator and adductor oculi at the bottom of the orbit, thence ascending by the sutura transversalis, becomes a round tendon, which paſſing through a pulley at the upper and inner part of the orbit near its edge, is inserted near the bottom of the globe of the eye, which it pulls upward and inward, and thereby directs the pupil outward and downward.

Obliquus inferior arises from the os maxillæ superioris, at the edge of the orbit; thence passing over the depressor is inserted near the ab-

ductor at the bottom of the eye; but not so low as the insertion of the obliquus superior: it turns the pupil upward and outward.

These muscles are inserted with great advantage to move a small weight, and are very long, that the eye may be moved with sufficient quickness. The two oblique muscles are an axis to the motions of the other four, and acting strongly against them, which action I take to be what is vulgarly called straining the eye, may, I think, bring the crystalline humour nearer to the retina, and possibly may make the crystalline humour more flat to fit the eye for objects at a great distance. For this end it seems to me that there are six muscles thus disposed, when three might be sufficient to turn the eye every way, if it was in a proper fixed socket: and it seems also, that while the muscles are all thus in action, the superior oblique in each eye sets the pupil farther from the nose, while the inferior oblique directs it upward; the first of which actions is always necessary, and the latter often so, when we look with both eyes at very distant objects; and when the two oblique muscles grow weak by age or disease, or cease to act at all, as in paralytic cases, and death, then the eye sinks in the orbit.

Sphincter, or constrictor oris, surrounds the mouth about three fourths of an inch broad. This muscle is very much intermixed with all the muscles that are inserted into it.

Elevator labii superioris proprius arises from the bone of the upper jaw under the anterior and inferior part of the orbicularis palpebrarum, and usually takes another small beginning from the os malæ, which seems as if it was sent off from the orbicularis palpebrarum; and passing down by the side of the nose, into which it sends some fibres, is inserted into the upper part of the sphincter oris. This raises the upper lip, and helps to dilate the nostrils.

Depressor labii superioris proprius is a small muscle arising from the upper jaw, near the dentes incisorii, and is inserted into the upper part of the lip and root of the cartilages of the nose; hence it is also a depressor of the nose, which action constricts the nostrils.

Depressor labii inferioris proprius arises broad from the lower jaw at the chin, and is soon inserted into the sphincter oris; the order of fibres in this seems not so conspicuous as in the other muscles of the face.

Elevator labii inferioris proprius arises from the lower jaw, near the dentes incisorii, and is inserted into the lower part of the lip.

Elevator labiorum communis arises from a depressed part of the superior maxilla under the middle of the orbit, and is inserted into the sphincter muscle near the corner of the mouth.

Depressor communis labiorum arises laterally from the lower jaw near the chin, and is

inserted into the sphincter opposite to the former.

Zygomaticus arises from the anterior part of the os zygoma or malæ, and frequently derives a portion of fibres from the orbicularis palpebrarum, thence running obliquely downwards. It is inserted into the sphincter at the corner of the mouth, betwixt the elevator communis and buccinator; it draws the corner of the mouth outward and upward. When this muscle grows weak, the corner of the mouth sinks, as may be observed in old persons.

Buccinator arises from the processus coronæ of the lower jaw, and passing contiguous to both jaws, is inserted into the sphincter muscle at the corner of the mouth. It serves either to force breath out of the mouth, or thrust the aliment between the teeth in mastication, or to pull the corner of the mouth outward.

Platysma myoides arises loosely from over the pectoral and part of the deltoid muscle, and running obliquely forward, is inserted into the chin, and depressor muscles of the lips. This muscle being exceeding thin, a mere membrana carnosa, serves to cover the unequal surface of the subjacent muscles, and render the neck even; it also pulls down the corner of the mouth, and, from its insertion at the chin, may contribute to the pulling down of the lower jaw.

Retractor alæ nasi is a very small muscle arising from the bone of the nose, and is inserted

into the skin and cartilage at the side of the nose.

Mylohyoideus with its fellow may be esteemed one penniform or else a digastric muscle. It arises from the linea aspera on the inside of the lower jaw and processus innominatus, both sides meeting at about right angles in a middle line upon the following muscles. It is inserted by a small portion of fibres into the basis of the os hyoides; it moves the tongue upward and forward, and also compresses the following muscles, whereby they raise the tongue more commodiously, and also hinders them from drawing the basis of the os hyoides into a right line betwixt the chin and sternum at such times as the stylohyoidei cannot act.

Geniohyoideus arises from the processus innominatus of the lower jaw, under the foregoing muscle, and is inserted into the basis of the os hyoides which it pulls upward and forward. This, with its fellow, are for the most part but one muscle.

Stylohyoideus arises from the processus styliformis, near its root, and passing contiguous to the horn of the os hyoides becomes inserted laterally into its basis. This muscle is sometimes perforated about the middle, by the tendon of the digastric muscle of the lower jaw. Its use is to pull the os hyoides up and backward.

Coracohyoideus arises from the upper costa of the scapula, near the processus coracoides, and

passing under the mastoideus muscle becomes in that place a round tendon; thence passing almost parallel to the following muscle, is inserted together with it into the basis of the os hyoides; this draws the os hyoides downward, and a little backward. I have once seen one of these muscles wanting, and the sternohyoideus arising from the middle of the clavicle on that side.

Sternohyoideus arises from a roughness at the under part of the clavicula near the sternum, and the cartilaginous part of the first rib; and is inserted into the basis of the os hyoides, to pull it downward.

Genioglossus arises from the processus innominatus of the lower jaw, and is inserted broad into the under part of the tongue, to pull it up and forward, and sometimes has a small insertion into the os hyoides.

Basioglossus seems a portion of the former muscle; it arises from the basis of the os hyoides, and is inserted into the tongue nearer its tip.

Ceratoglossus arises from the horn of the os hyoides, and is laterally inserted into the tongue near its root, to pull it downward and forward.

Styloglossus arises from the extremity of the processus styliformis, and is inserted into the tongue near the former to pull it up and backward. I have very often found another styloid muscle so inserted, that I cannot tell whether to call it a muscle of the tongue or pharynx.

The tongue is a muscle made of fibres, longitudinal, circular, and transverse, so intermixed as best to serve its several motions.

Hypothyroideus or Ceratothyroideus, arises from part of the basis, and the horn of the os hyoides, and is inserted into the lower part of the cartilago thyroides, to pull it forward.

Sternothyroideus arises from the inside of the sternum, and is inserted with the former; it pulls the thyroid cartilage directly downward.

Cricothyroideus arises from the anterior part of the cartilago cricoides, and running obliquely upward and outward, is soon inserted into the inside of the cartilago thyroides, which it pulls towards the cartilago cricoides. Both this muscle and its fellow for the most part appear double.

Cricoarytænoideus posticus arises from the back part of the cartilago cricoides, and is inserted into the arytænoides to pull it backward.

Cricoarytænoideus lateralis arises laterally from the cartilago cricoides, and is inserted laterally into the arytænoides. This, with its fellow, pull down each cartilage toward their origin, and thereby dilate the rimula.

Thyroarytænoideus arises from the superior, middle, and inner part of the cartilago thyroides, and is inserted with the former into the arytænoides cartilage to dilate the rimula. These two last described muscles are not naturally divided, and therefore ought to be accounted but one muscle.

Arytænoideus is one single muscle, which arises from one arytænoidal cartilage, and is inserted into the other, to draw them together, and close the rimula. These few small muscles of the tongue and larynx, with only one pipe, make a great variety of notes and sounds that can be made by artificial instruments, and that in a manner so little understood by us, and by organs so little differing from those in quadrupeds, that, for aught we know of them, brutes might be as capable of all these sounds as men.

Stylopharyngæus arises from near the bottom of the processus styloides of the os petrosum, and running obliquely downward, is inserted into the pharynx. This muscle, with its fellow, pulls up and dilates the pharynx to receive the aliment.

Œsophageus arises like a wing from several parts of the scull, tongue, os hyoides, the cricoid and thyroid cartilages, and is inserted into the pharynx. This, with its fellow, constringes the pharynx, and presses the aliment down the gullet.

Musculus vaginalis gulæ is the muscular coat of the gula.

Pterygopharyngæus is not a distinct muscle, but the beginning of the pharynx near the processus pterygoides of the sphenoidal bone.

Pterygostaphylinus internus arises from the os sphenoides, near the iter ad palatum, or eustachian tube, and is inserted into the uvula,

which it pulls up while we breathe through the mouth, or swallow.

Pterygo-staphylinus externus arises by the side of the last described muscle, and is also inserted near it; but becomes its antagonist by being reflected on a pulley, over a process at the lower part of the pterygoidal processes of the sphenoidal bone.

Glosso-staphylinus is a very small portion of muscular fibres, which pass from the tongue to the palate, which it pulls down when we breathe through the nose.

The palate itself is a sort of double muscle, whose action seems only to support itself, and assist those muscles which pull it upwards.

Digastricus arises from sinus of the mammillary process of the os temporis, and, from a fleshy belly becoming a round tendon, passes through, and sometimes under, the stylohyoideus muscle; and then, being tied down by a ligament to the os hyoides, grows fleshy, and is so inserted into the anterior part of the lower jaw internally. This muscle's direction being altered by its being tied to the os hyoides, where it makes an angle, and not at its passage through the stylohyoideus, pulls the lower jaw downward with much greater force than otherwise it could have done; and being connected to the os hyoides, when it acts, it prevents the action of several muscles which are concerned in swallowing; whence it is that we cannot swal-

low at the same time that we open the jaw, as those brutes can whose digastric muscles are not connected to that bone.

Temporalis arises from the os frontis, parietale, sphenoides, malæ, and temporis, and, passing under the two processes named os jugale, is inserted externally into the processus coronalis of the lower jaw, which it pulls upward. This muscle is covered with a strong tendinous fascia.

Masseter arises from the lower edge of the os malæ or zygoma, and the process which joins this from the temporal bone, and is inserted into the outer part of the angle of the lower jaw, which it pulls up and forward. These two last described muscles having different directions, when they act together, make a steady motion in the diagonal of their directions.

Pterygoideus internus arises from the processus pterygoideus externus, and from the sinus between the pterygoid processes, and is inserted internally into the angle of the lower jaw, which it pulls upward.

Pterygoideus externus arises from the os maxillare and os sphenoides, near the root of the external pterygoid process, and is inserted internally into the processus condyloides of the lower jaw, which it pulls to one side, and forwards, or acting with its fellow pulls the jaw directly forward.

Subclavius arises from the superior part of the first rib, and is inserted into more than half the

underside of the clavicula next the scapula. Its use is to draw the clavicula toward the sternum, that they may not be severed in the motions of the scapula.

Trapezius arises from the os occipitis, and from a linea alba colli, from the spinal process of the last vertebra of the neck, and the ten uppermost of the back, and from a linea alba between all these processes; and is inserted into one third of the clavicle next the scapula, almost all the back part of the spine of the scapula, and as much of the processus acromion as lies between the spine of the scapula and the clavicle. This muscle draws the scapula directly backward.

It is generally said by authors, that the several parts of this muscle act at different times, and so pull the scapula different ways, as obliquely upward, downward, or backward; but, I think, if that happened, it must necessarily divide this muscle into distinct portions, those that contract always separating from those that do not.

Rhomboides arises tendinous under the former from the spinal process of the inferior vertebra of the neck, part of the linea alba colli, and from the spinal processes of the four or five uppermost vertebræ of the thorax, and is inserted into the basis of the scapula, which it pulls up and backward. The upper part of this muscle arising from the neck, is, in many bodies, by the motions of the neck, separated and made a distinct muscle.

Elevator scapulæ arises from the transverse processes of the four superior vertebræ of the neck, and is inserted into the upper angle of the scapula.

Serratus minor anticus arises under the pectoralis, from the third, fourth, and fifth ribs, and is inserted into the processus coracoides scapulæ, which it pulls forward and downward. This muscle is always said to be an elevator of the ribs, though it arises from the scapula, which is supported by the ribs.

Serratus major anticus arises from the anterior part of the eight superior ribs, and is inserted into the basis of the scapula, which is draws forward, and by that means moves the socket of the scapula upward. This muscle has been always accounted an elevator costarum, though each portion of it is nearly parallel to the rib it rises from.

All the muscles inserted into the basis of the scapula are also inserted into one another.

Pectoralis arises from near two thirds of the clavicula, next the sternum, and all the length of the os pectoris, and from the cartilages of the ribs, and is inserted into the os humeri, between the biceps and the insertion of the deltoides. The use of it is to draw the arm forward. A small portion of the lower part of this muscle is often confounded with the obliquus descendens abdominis; and in some bodies, neither the upper part, nor its tendon, can be easily separated from the deltoides; and in

others, even that part of it that arises from the clavicula is a distinct portion. Near the insertion of this muscle the fibres cross those from below, ending above in the arm, and those from above below, that the tendon of this muscle might not lie inconveniently low between the arm and thorax, as it would have done had the fibres which arise lowest from the sternum been inserted lowest in the arm; but this crossing does not make the tendon at all stronger, as is often said; nor can I see how it came to be thought that this tendon should want more strength in proportion than other tendons.

Deltoides arises exactly opposite to the insertion of the trapezius, from one third part of the clavicula, from the acromion and spine of the scapula, and is inserted tendinous near the middle of the os humeri, which bone it lifts directly upward. The outermost parts of this muscle, when the arm hangs down, lie below the centre of motion of the joint, and therefore can have no share in lifting the humerus up, till it is raised part of the way by the other part of this muscle, and the following muscle; and as the outer parts of this muscle begin to act, the following muscle acts with less advantage: and it seems to me, that the sole reason why this muscle is made of so many parts, is, that they may act independently; for it is demonstrable, that this muscle, when the whole of it acts, cannot raise the arm with so great advantage as a right lined muscle of the same magnitude would have done.

Supraspinatus arises from the dorsum scapulæ above the spine, and passing between the two processes, is inserted into the upper part of the os humeri, which it helps to raise until it becomes parallel with the spina scapulæ.

The supraspinatus, the deltoides, and coracobrachialis assist in all the motions of the humerus except depression; it being necessary that the arm should be raised and sustained, in order to move it to any side.

Infraspinatus arises from the dorsum scapulæ below the spine, and is inserted, wrapping over part of it, at the side of the head of the os humeri; it turns the arm supine and backward; for there is a prone and supine rotatory motion of the humerus of near ninety degrees.

Teres minor is a small muscle arising below the former from the inferior costa scapulæ, and is inserted together with it. It assists the former in turning the arm supine, but pulls it more downwards.

Teres major arises from the lower angle of the scapula, and is inserted at the under part of the os humeri, about three fingers breadth from the head. This draws the os humeri toward the lower angle of the scapula, and turns the arm prone and backward.

Latissimus dorsi arises by a flat tendon from the spinal processes of the seven or eight inferior vertebræ of the back, and those of the loins, sa-

crum, and ilium: and growing fleshy, after it has passed the extensors of the trunk, receives another small fleshy beginning from the ninth, tenth, and eleventh ribs, and is inserted into the os humeri, with the former. This turns the arm backward, and prone. The tendon of this muscle serves for a membrane to the extensors of the back, and is connected to the transverse processes of the vertebræ lumborum.

Subscapularis arises from the hollow side of the scapula, which it fills up, and is inserted into the head of the os humeri, wrapping somewhat over it. This pulls the arm to the side and prone.

Coracobrachialis arises from the processus coracoides scapulæ, in common with the origin of one head of the biceps, and is inserted into the os humeri internally about its middle. This raises the arm, and turns it somewhat outward.

Biceps cubiti flexor arises with two heads, that the fibres of this muscle might not compress one another, one from the processus coracoides scapulæ, in common with the coracobrachialis muscle, and the other by a round tendon from the edge of the acetabulum scapulæ, which passing in a sulcus of the os humeri, afterward becomes fleshy, and joins the first head to be inserted with it into the tubercle of the radius; and sometimes this muscle has a third head, which arises from the middle of the os humeri. This muscle lifts up the

humerus, bends the cubit, and has as great a share as any one muscle in turning the cubit supine; the humerus being fixed by other muscles, the whole force of this muscle will be exerted upon the cubit; or the cubit being fixed by an extensor, the whole force of it will be spent in raising the arm, and therefore ought to be always reckoned among those that raise a weight at arms length. A puncture of the tendinous expansion of this muscle is supposed to be always attended with grievous pain and inflammation, and has, if we have not mistaken the cause, often proved mortal; yet many eminent surgeons have given instances of larger tendons being cut and stitched, without any bad symptoms; and we have often seen them cut, torn, ulcerated, and mortified, without any more sign of pain than in other parts. So that I cannot see what the great mischief of pricking this tendinous fascia is owing to, unless its lying so much upon the stretch, which may be wholly avoided by bending the elbow, and turning the cubit prone. Since I have considered this case, I have met with one who was thus injured by an injudicious blood-letter, who ordered the patient to keep her arm extended for fear of a contraction, and she was not without the most violent pain for a whole fortnight; but upon bending the cubit, and turning the arm prone, she grew presently easy, and, in a few days, well. Nevertheless, I am persuaded, that most of the accidents

which are thought to be merely from blood-letting, are critical discharges of some disease, and from the puncture a small inflammation beginning, increases and suppurates. But however singular I may be thought in this opinion, I can be sure I am disinterested in it, having never had any ill accident follow blood-letting in my life.

Brachiæus internus arises from below the middle of the os humeri, and is inserted into a rough place of the ulna, immediately below the the juncture. This also bends the cubit.

Supinator radii longus arises from the lower and outer part of the os humeri, and is inserted into the upper side of the radius, near the carpus. This muscle is not a supinator but a bender of the cubit, and that with a longer lever than either of the two former muscles, and is less concerned in turning the cubit supine, than either the extensors of the carpus, fingers, or thumb.

Triceps extensor cubiti, commonly distinguished into biceps and brachiæus externus. The first of these heads arises from the lower costa of the scapula near the acetabulum; the second from the outer and back part of the os humeri; the third, lower and more internal; and are inserted into the processus olecranon of the ulna. The first of these heads draws the arm backward, with as long a lever as it extends the cubit.

Anconæus arises from the outward extuberance of the os humeri, and is inserted into the upper part of the ulna: this is also an extensor.

Palmaris longus arises small from the inner extuberance of the os humeri, and from a short belly soon becomes a tendon, which is connected to the ligamentum transversale carpi, and expanded in the palm of the hand. This muscle is often wanting, but the expansion in the hand never; yet it being connected to the ligament of the carpus, it must bend the carpus, and cannot constrict the palm of the hand; and when it is wanting, the flexor carpi radialis is larger.

Palmaris brevis, or caro quadrata, arises obscurely from the ligamentum transversale carpi, and seems to be inserted into the eighth bone of the carpus, and the metacarpal bone of the little finger. This helps to constrict the palm of the hand, and is very different in size in different bodies.

Flexor carpi radialis arises from the inner extuberance of the os humeri, and soon becoming a strong tendon, passes through a channel of the fifth bone of the carpus, and is inserted into the metacarpal bone of the fore-finger. This not only bends the carpus upon the radius, but also the bones of the second order upon those of the first; which motion is nearly as much as that upon the radius.

Flexor carpi ulnaris arises from the same extuberance with the former, and a fascia betwixt this muscle and the tensor ulnaris contiguous to the

ulna, and is inserted by a short tendon into the fourth bone of the carpus.

Extensores carpi radiales; the first arises from the os humeri, immediately below the supinator radii longus, and is inserted into the metacarpal bone of the first finger; the second arises immediately below this, from the outer extuberance of the os humeri, and is inserted into the metacarpal bone of the second finger. The first of these muscles is a bender of the cubit, as well as an extensor of the carpus, and its often acting with the benders of the cubit while the other is not in action, is the reason why it is so distinct from it.

Extensor ulnaris arises from the same extuberance with the former, and half the ulna below the anconeus muscle; then becoming a tendon, runs in a small sinus at the bottom of the ulna, and is inserted into the metacarpal bone of the little finger. See Ulna, p. 31, 32. The extensors of the carpus being inserted into the metacarpus, at once perform the motion between the bones of the carpus, and that between the carpus and radius. The flexor and tensor ulnaris acting together turn the hand downward, the tensor and flexor radialis upward.

Perforatus, or flexor secundi internodii digitorum, arises from the inner tubercle of the os humeri, and from the upper part of the ulna, and the middle of the radius; then becoming four strong tendons, passes under the ligamen-

tum transversale carpi, and is inserted into the beginning of the second bone of each finger.

Perforans, or flexor tertii internodii digitorum, arises from half the ulna, and a great part of the ligament between the ulna and radius, then becoming four tendons, passes under the ligamentum transversale carpi, and through tendons of the former muscle to their insertion into the third bone of each finger. The tendons of both these muscles are tied down to the fingers by a strong ligament. If these muscles had not passed one through the other, the perforatus, which is the lesser muscle, must have gone to the last joint where the stronger muscle is wanted; and, besides, the tendons of the second joints would have pressed those that bend the last, and not lain firmly upon them neither.

Lumbricales, or flexores primi internodii digitorum, arise from the tendons of the last mentioned muscle, and are inserted laterally toward the thumb into the beginning of the first bone of each finger.

Extensor digitorum communis arises from the outer extuberance of the os humeri, and passing under a ligament at the wrist, is divided into four tendons, which communicate upon the first joint, which keeps them from sliding off the joints of the fingers, where they are a little connected to the first bones, and afterward are inserted into the beginning of the second bone of each finger.

Extensor auricularis, or minimi digiti is a portion of the last muscle passing under the ligament in a distinct channel.

Extensor indicis arises from the middle of the ulna, and passing under the ligament of the carpus, is inserted with the extensor communis into the fore-finger. This muscle extends the fore-finger singly. I have twice seen it wanting.

Abductor primi digiti, intcrossei, and abductor minimi digiti, are eight muscles, one for each side of each finger. Abductor primi digiti arises from the first bone of the thumb, and the side of the metacarpal bone of the first finger. The interossei are three pair, fitly divided into external and internal; the external arise from the metacarpal bones, whose spaces they fill up next the back of the hand; the internal arise from the same bones, in the inside of the hand. Abductor minimi digiti arises from the transverse ligament, and fourth bone of the carpus; these muscles are inserted, two into the first joint of each finger, and then passing obliquely over the tops of the fingers, are inserted into their last bones; they bend the first joints, and extend the two last, as in holding a pen, and in playing upon some musical instruments. The abductors of the fore and little fingers, with the second and fifth interossci muscles acting, the fingers are divaricated, and the other four acting bring them together, and these muscles which divaricate the

fingers, being extenders of the second and third joints, we never can divaricate them without extending them a little.

Adductorossis metacarpiminimi digiti arises from the eighth bone and transverse ligament of the carpus, and is inserted into the metacarpal bone of the little finger, which it pulls toward the thumb to constrict the palm of the hand.

Extensor primi internodii pollicis arises from the ulna below the anconeus muscle, and the ligament between the ulna and radius; then becoming two, three, or four tendons, is inserted into the fifth bone of the carpus, and first of the thumb. The first of these insertions can only assist the bending of the wrist upward, and in turning the arm supine.

Extensor secundi internodii pollicis arises immediately below the former from the radius and transverse ligament, and is inserted by a few fibres into the second bone of the thumb, but chiefly into the third.

Extensor tertii internodii pollicis arises immediately below the last described, from the ulna and ligament, and passes over the radius nearer the ulna, to be inserted at the third bone of the thumb. This extends the thumb more toward the ulna than the former muscle, and is very much a supinator.

Flexor primi et secundi ossis pollicis arises from the fifth bone and transverse ligament

of the carpus, and from the beginnings of the two first metacarpal bones, and is inserted into the whole length of the first bone of the thumb, and tendinous into the beginning of the second; the sesamoid bones of the thumb in such bodies as have them, lie in this tendon, where it passes over the joint.

Flexor tertii internodii pollicis arises large from almost all the upper part of the radius, and becoming a round tendon, passes under the ligamentum transversale carpi, to be inserted into the third bone of the thumb. This muscle singly acting, draws the thumb towards the metacarpal bone of the little finger; but the last mentioned muscle acting with it, turns it toward the fore-finger.

Adductor pollicis arises from the carpus, and almost the whole length of the metacarpal bone of the long finger, and is inserted into the beginning of the second bone of the thumb. This muscle naturally enough divides into two, and might better be called a flexor than adductor.

Abductor pollicis arises from the fifth bone and ligamentum transversale of the carpus, and is inserted laterally into the beginning of the second bone of the thumb, to draw it toward the radius.

The muscles which bend the thumb are much less than those which bend the fingers; nevertheless, the thumb is able to resist all the fingers,

merely from the advantages that arise from the thickness and shortness of the bones of the thumb, compared with those of the fingers; but then the quickness of motion in the fingers will exceed that of the thumb, as much as the fingers exceed the thumb in length, and their muscles those of the thumb in largeness.

Supinator radii brevis arises from the outer extuberance of the os humeri, and upper part of the ulna, and running half round the radius, is inserted near its turbercle.

Pronator teres arises from the inner apophysis of the os humeri, and upper and fore part of the ulna, and is inserted tendinous into the radius below the former.

Pronator quadratus arises from the lower edge of the ulna, near the carpus, and passing under the flexors of the fingers is inserted into the radius.

These muscles are occasionally assisted in their actions by the muscles of the hands, the extensors assisting the supinators, and the flexors the pronators, and most of the extensors of the hand take a great part of their origin from the tendinous fascia that covers them.

Mastoideus arises tendinous from the sternum near the clavicula, and by a separate fleshy portion from the clavicula, which soon unites with the other beginning, and is inserted into the outer part of the mammillary process of the temporal bone. It pulls that side of the head it is inserted

into towards the sternum, and turns the face toward the contrary shoulder. This, and its fellow, pull the head and neck toward the breast, and act with a much longer lever upon each lower vertebra, than they do upon the next above, and with more power upon any of those joints than upon the head. This muscle being inserted into the head, beyond the centre of motion of the head with the first vertebra, has been supposed, by several anatomists, to pull the head backward; but the passing beyond signifies nothing to that purpose, unless a line going through its axis would pass below the centre of motion: and it is the more to be wondered how this mistake prevailed, if we consider that this muscle's being added to the extensors of the head and neck, would make the force of that action a hundred times greater than that of the benders. And if this is not enough to convince, let any one lying on his back raise his head, and he will soon feel this muscle in action; but bowing the head forward in an erect posture will not shew this unless some resistance is made to the head, because the centre of gravity of the head lying before the centre of motion, there needs no more than a relaxation of the extensors, to bring the head forward in that posture.

Rectus internus major arises from the anterior part of the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ; and passing over the two superior, is inserted into a rough-

ness of the occipital bone near the fore-part of the great foramen. This bends the head on the two first vertebræ of the neck.

Rectus minor internus arises under the last muscle, from the first vertebra, and is inserted under it into the os occipitis. This bends the head on the first vertebra.

Rectus lateralis arises from the anterior part of the transverse process of the first vertebra of the neck, and is inserted into the os temporis and occipitis between the mammillary and styloid processes. This turns the head on one side.

Splenius arises by a thin tendon from the spinal processes of the five superior vertebræ of the thorax, and the lowest of the neck, and linea alba colli, and is inserted into the os occipitis, the upper part of the mammillary process of the temporal bone, and the transverse processes of the three superior cervical vertebræ. This pulls the head and neck backward, and to the contrary side ; but both of these acting together pull them directly backward.

Complexus arises from the transverse processes of the six or seven superior vertebræ of the thorax ; and six inferior of the neck, and is inserted into the os occipitis, and back part of the os temporis ; this last part is sometimes distinct enough to be accounted another muscle. It pulls the head and neck back.

Rectus major posticus arises from the spinal processes of the second vertebra of the neck, and is inserted broader into the os occipitis. It pulls the head back on the two first vertebræ.

Rectus minor posticus arises from the back part of the first vertebra of the neck, it having no spinal process, and is inserted below the former into the same bone, to pull the head back on the first vertebra.

Obliquus superior arises from the transverse process of the first vertebra, and is inserted into the os occipitis and back part of the os temporis, near the rectus major; either of these acting, assist the rectus lateralis on the same side; but both together pull the head back.

Obliquus inferior arises from the spinal process of the second vertebra of the neck, and is inserted into the transverse process of the first. This, with its fellow, alternately acting, turns the head with the first vertebra in a rotatory manner on the second, whose processus dentatus is the axis of this motion.

Interspinales colli are three or four pair of muscles between the bifid processes of the cervical vertebræ, which they draw nearer each other when the neck is bent backward.

Longus colli arises laterally from the bodies of the four superior vertebræ of the thorax, and from the anterior part of the transverse processes of the five inferior vertebræ of the neck, and is in-

serted into the fore part of the first and second vertebræ of the neck, which it bends forward.

Intertransversales colli are portions of flesh between the transverse processes of the vertebræ of the neck, like the interspinales, but not so distinct; they draw these processes together.

Spinalis colli arises from the transverse processes of the five superior vertebræ of the back, and is inserted into the spinal processes of the second, third, fourth, and fifth vertebræ of the neck. This pulls the neck backward.

Transversalis colli arises from the oblique processes of the four inferior vertebræ of the neck, and is inserted into the spinal process of the second vertebra of the neck. This muscle is but a continuation of the transversalis or semispinalis dorsi.

The muscles of the head and neck are most of them obliquely directed, which makes them perform the oblique motions, as well as extension and flexion; which is highly convenient in this case, because the joints moved by these muscles, being under the weight moved, it is necessary that the head should be kept steady by the extensors, and flexors too, when any great weight is upon the head; and these muscles, from the obliquity of their directions, not only perform these two actions at once, but acting by pairs they move the head and neck steadily, in a diagonal direction, which straight muscles could not have done so well.

Scalenus arises from the transverse processes of the second, third, fourth, fifth and sixth cervical vertebræ. It is inserted, in three parts, into the two uppermost ribs, being thus divided for the transmission of the subclavian vessels. This muscle may bend the neck; but its chief use is to support the upper ribs, which is necessary to determine the contraction of the intercostal muscles that way, and a ligament could not have done this, because of the various positions that the neck and back are liable to.

Serratus superior posticus arises with a thin tendon, inseparable from the rhomboides, from the spinal process of the inferior cervical vertebra, and the three superior of the thorax, and is inserted into the second, third, and fourth ribs, immediately beyond their bendings; this, with the scalenus, sustains the upper ribs, that they might not be pulled downward by the depressors of the ribs in exspiration, as the lower ribs are upward in inspiration.

Serratus inferior posticus arises with a broad tendon, inseparable from that of the latissimus dorsi, from the spinal processes of the three superior vertebræ of the loins, and two inferior of the thorax, and is inserted into the tenth rib, but chiefly the ninth and eleventh: it pulls down the ribs in exspiration.

Intercostales are eleven pair on each side, in the interstices of the ribs; from their situations

distinguished into the external and internal; they all arise from the under edge of each rib, and are inserted into the upper edge of the rib below. The external are largest backward, having their first beginnings from the transverse processes of the vertebræ, like distinct muscles, which some call levatores costarum. The internal run all from above obliquely backward; being thickest forward, and thinnest toward the spine. These are also continued betwixt the cartilages of the sternum, with fibres perpendicular to the cartilages; and between the cartilages of the lowest ribs, they are inseparable from the obliquus ascendens abdominis. These muscles, by drawing the ribs nearer to each other, pull them all upward, and dilate the thorax, they being sustained at the top by the scalenus and serratus superior posticus. To these Mr. Cowper adds some fleshy fibres, which run from one rib over a second to a third, near the spine, which are levatores costarum.

Triangularis sterni arises internally from the cartilago ensiformis, and the lower edge of the os pectoris, and is inserted into the end of the third, fourth, fifth and sixth ribs. This pulls the ribs to the bone of the sternum, and thereby bends its cartilages in exspiration.

Diaphragma arises, on the right side, by a process from three lumbal vertebræ, and one of the thorax; and on the left, from the one superior of the loins, and inferior of the thorax; this last part

being less to give way to the great artery, and is inserted into the lower part of the sternum and the five inferior ribs. The middle of this muscle is a flat tendon, from whence the fleshy fibres begin and are distributed, like radii, from a centre to a circumference. When this muscle acts alone, it constricts the thorax, and pulls the ribs downward, and approaches toward a plane; which action is generally performed to promote the ejection of the fæces. In large inspirations, when the intercostals lift up the ribs to widen the thorax, this muscle acts enough to bring itself toward a plane, without overcoming the force of the intercostals, by which means the breast is at once widened and lengthened: when it acts with the abdominal muscles, it draws the ribs nearer together, and constricts the thorax, and the superior force of the abdominal muscles thrusting the parts of the lower belly against it, it becomes at the same time convex upward, and shortens the thorax, which occasions the largest exspirations; or acting alternately with the abdominal muscles only, a more moderate inspiration and exspiration is made by shortening and lengthening the thorax only, which is what we chiefly do when lying down; or acting alternately with the intercostals only, a moderate exspiration and inspiration is caused, by the widening and narrowing the breast, which is what we are most prone to in an erect position, the muscles of the abdomen at such times being employed in supporting the parts con-

tained in the abdomen. And though these motions of the ribs require at any one time but very little force, the air within the thorax balancing that without; yet that these muscles, whose motions are essential to life, may be never weary, the inspirators in most men have force sufficient to raise mercury in a tube four or five and twenty inches in an erect posture, and the exspirators six or seven; the first of which will require about four thousand pound force in most men, and the other proportional. But I imagine, that lying down, these proportions will differ by the weight of the parts contained in the abdomen. In all the bodies I have dissected, I have found the diaphragm convex upward, which gave me occasion to think, that all animals died in exspiration; till the forementioned experiment discovered, that the muscles of inspiration were stronger than those of exspiration; which led me to make the following experiment. I cut the wind-pipe of a dog, and having a string ready fixed, I put a cork into it, and tied it fast instantly after inspiration; upon which I observed, that the diaphragm, and the other muscles of inspiration and exspiration, were alternately contracted and distended for some time; but when he was dead, the abdominal muscles were in a state of contraction, the ribs were elevated to dilate the thorax, and the diaphragm was convex upward. This experiment also shews, that the diaphragm is not a muscle of equal force either to the depressors or elevators of

the ribs, it neither hindering the elevators from raising the breast; nor the depressors from thrusting it upward, by compressing the parts contained in the abdomen, though the breast was full of air.

Sacer sacrolumbalis, longissimus dorsi, and semispinalis, are all that portion of flesh betwixt the os sacrum and the neck, which seeing there is no membrane to distinguish it into several muscles, and that it is all employed in the same actions, I shall give it the name of extensor dorsi et lumborum, and describe it all as one muscle.

Extensor dorsi et lumborum arises from the upper part of the os sacrum, the spine of the os ilium, the back parts of the lowermost vertebræ of the loins, and remarkably from those strong tendons which appear on their outsides. That part of this muscle, which is known by the name of sacrolumbalis, is inserted into all the ribs near their articulations, with the transverse processes of the vertebræ, and into the transverse process of the last vertebra of the neck; besides, as this passes over the ribs, it receives an origin from every rib, in a manner that cannot well be described. The portions of this muscle, which arise from the ribs, and are inserted into the other ribs above, will necessarily draw the back part of the ribs nearer together, which must always be done as the back extends, and independent of other actions of the thorax. The next portion of this muscle, called longissimus

dorsi, is inserted into all the transverse processes of the vertebræ of the back, and partly into the ribs, and the uppermost transverse processes of the vertebræ of the loins; and the upper end of it is neither very distinct from the complexus of the head, nor spinalis of the neck. The rest of this muscle, known by the names of semispinalis, sacer, &c. arises also from all the transverse and oblique processes of the loins and back; every portion, except the lowermost, passing over five joints, is inserted into the spinal process of the sixth vertebra above its origin, all the way up the back, and at the neck commences transversalis colli. This passing of each portion of a muscle over a few joints, distributes their force equally enough among all these joints, without the fibres being directed more obliquely than those of penniform muscles; but the neck and loins not having sufficient provision of this sort, there are small muscles between their processes, which, though they are of little importance for the motions of those parts, yet are sufficient to distribute the force of larger muscles equally among those joints; and, besides the uses of the extensor dorsi et lumborum, which its name implies, it and its fellow alternately raise the hips in walking, which any one may feel by laying his hand upon his back.

Quadratus lumborum arises from the upper part of the spine of the ilium, and is inserted into all the transverse processes of the four upper-

most lumbal vertebræ. This, and its fellow, acting alternately, assist the last mentioned muscle in raising the ossa innominata in progression : or each acting singly, while the lower limbs are not moved, inclines the body to one side.

Intertransversales lumborum, are small muscles seated between all the transverse processes of the vertebræ lumborum, to bring them nearer together.

Psoas parvus arises laterally from the body of the first lumbal vertebra, and the lowest of the back, and soon becoming a small tendon, is inserted into the os pubis, near the ilium. It either assists in bending the loins forward, or raising the os innominatum in progressive motions. This muscle is often wanting.

Psoas magnus arises laterally from the bodies and transverse processes of the four superior vertebræ of the loins, and the last of the back, and is inserted with the following muscle into the lesser trochanter. This bends the thigh, and when the psoas parvus is wanting, this is larger.

Iliacus internus arises from the concave part of the ilium, and from its lower edge, and passing over the ilium, near the os pubis, joins the former muscle, and is inserted with it, to be employed in the same action.

Pectineus arises from the os pubis or pectinis, near the joining of that bone with its fellow, and is inserted into the linea aspera of the thigh bone,

four fingers breadth below the lesser trochanter. This bends the thigh, and turns the toes outward.

Triceps femoris. The two lesser heads of this muscle arise under the pectineus, and the third from the inferior edges and back part of the os pubis and ischium, and is inserted into the whole length of the linea aspera and the inner apophysis of the os femoris. This also bends the thigh, and turns the toes outward. When the thigh bone is moved in a plane, which cuts at right angles a plane that passes through the axis of either head of the last muscle, that head rising lower than the centre of motion of the hip joint, it will either assist the flexors or extensors, and that most when the bone has been moved most backward or forward: and as either of these heads lie more or less out of the said plane, they will give greater assistance to that motion which is made on the side of the said plane, contrary to their situation, and less on the same side. This mechanism is frequently made use of to make one muscle serve different actions; but I have only explained it in this instance, because it is the most considerable one that I know.

Cluteus maximus arises from the back part of the spine of the ilium, and the dorsum ilii, and side of the os coccygis and sacrum, and a ligament extended between these bones, and from a thin fascia, spread over that part of the following muscle which this does not cover, and is inserted

by a strong tendon into the upper part of the linea aspera of the thigh bone, and also into the flat tendon of the fascialis muscle, which insertion into, or connexion with, that tendon, raises this muscle farther from the centre of motion, and increases its strength. This extends the thigh, and both these together being contracted, occasionally assist the levatores ani in supporting the anus. The breadth of the origin and insertion of this muscle is very observable; for by that means, though it is the largest muscle in the body, it is nevertheless right-lined, without one fibre compressing another any more than in penniform muscles.

Gluteus medius arises from all the anterior part of the spina and dorsum ilii, and under part of the last mentioned muscle, and is inserted into the upper part of the great trochanter of the thigh bone. This extends the thigh outward.

Gluteus minimus arises entirely under the former, from the dorsum ilii, and is inserted into the upper and anterior part of the great trochanter and neck of the thigh bone to extend the thigh.

Pyriformis arises internally from the inside of the os sacrum, and growing, in more than half its progress, into a round tendon, is inserted into the upper part of the sinus, at the root of the great trochanter. This assists somewhat in extending the thigh, but more in turning it outward.

Quadratus femoris arises from the obtuse process of the ischium, and is inserted into the up-

per part of the linea aspera of the thigh bone, between the two trochanters. This draws the thigh inward, and directs the toes outward.

Obturator internus or marsupialis arises generally from a strong membrane, or ligament, which fills up the hole of the os innominatum, and from the circumambient bone; thence passing over a channel in the ischium, betwixt its two processes, it receives from them two other portions, which are a sort of marsupium, and is inserted into the sinus of the great trochanter. This turns the thigh outward.

Obturator externus arises opposite to the former, from the outside of the os innominatum, and is inserted into the sinus of the great trochanter. This also turns the thigh outward. These four last mentioned muscles acting with the extensors, prevent their turning the toes inward, and in stepping forwards are continually acting to turn the toes outwards; for though the toes are placed perpendicular to the front of the body, in taking a long ſtep, these muscles bring them perpendicular to the side of the body; and as these direct, the same extensors will turn the thigh either outward or backward, with their full force.

Fascialis, or membranosus, arises from the forepart of the spine of the ilium, and in about five inches progress becomes a flat tendon, or fascia, which is joined by a considerable detachment from the tendon of the gluteus maximus, and

from the linea aspera of the thigh bone, and then covering in an especial manner the vastus externus, is inserted at the top of the tibia and fibula, and then proceeds to join the fascia, which covers the upper part of the muscles situate on the outside of the tibia, and from which a great part of the fibres of those muscles arise. About the middle of the leg it grows loose, and is so continued to the top of the foot, being connected there, and at the lower part of the leg, to the ligaments which tie down the tendons. This tendon, where it covers the vastus externus, receives additional transverse fibres, which run through the thigh, but are most conspicuous on the outside. This draws the thigh outward, and passing over the knee forwarder than its axis of motion, it will help to extend that joint.

Gracilis arises from the os pubis, close to the penis, and is inserted into the tibia, four or five fingers breadth below the knee. This draws the thigh inward, and passing over the knee, behind its axis of motion, it will help to bend it.

Sartorius arises from the fore part of the spine of the ilium, and thence descending obliquely to the inside of the tibia, is there inserted four or five fingers breadth below the joint. This at once helps to bend both the thigh and leg, particularly the thigh, at very long levers; it directly helps to lift up the leg in walking up stairs, or laying the legs across, like taylors.

Semitendinosus arises from the obtuse process of the ischium, and growing a round tendon in somewhat more than half its progress, is inserted near the former muscles into the tibia : it helps to extend the thigh and bend the tibia.

Semimembranosus arises by a flat tendon like a membrane from the obtuse process of the ischium, and being continued tendinous betwixt the bellies of the last mentioned and following muscles, and then growing fleshy, becomes again tendinous above the joint, and is inserted nearer the joint than the former muscle for the same use.

These two make the internal hamstring, and arising and inserting so near together, they might have been one muscle, but their fibres would have been near twice as long, which would have given a motion near twice as quick, but not so strong, unless it had been inserted at a distance from the joint it moves proportionable to its length, which could not well be; therefore they are made two muscles of a number of fibres nearly equal to what one could have been, and are inserted at distances from the axis of motion of the knee, proportional to the different lengths of their fibres in the directions of their axis.

Biceps tibiæ, the first head arises in common with the two preceding muscles, from the obtuse process of the ischium; the second from the lower part of the linea aspera of the thigh bone. This soon joins the former, and is inserted with it into

the upper part of the fibula to bend the leg, and the first head also extends the thigh. The tendon of this muscle makes the external hamstring, when the knee is bent; and when we sit down, the biceps will turn the leg and toes outward, and the semitendinosus and semimembranosus will turn them inward.

Popliteus arises from the outer apophysis of the os femoris, and thence running obliquely inward, is inserted into the tibia immediately below its head. This assists the flexors, and draws the tibia toward the outer apophysis of the thigh bone.

Rectus tibiæ arises with a tendon from the upper part of the acetabulum of the os innominatum, and by another tendon, which is a sort of ligament to this, from a processus innominatus of the ilium below its spine forward, and is inserted, together with the three following muscles, into the patella. It bends the thigh, and extends the tibia.

Vastus externus arises from the anterior part of the great trochanter and upper part of the linea aspira of the thigh bone, and is inserted into the upper and external part of the patella. It extends the tibia.

Vastus internus arises from the inner and lower part of the linea aspera, and is inserted into the upper and inner part of the patella, to extend the tibia; and the fibres of this muscle being oblique, it keeps the patella in its place, the other muscles lying in the direction of the os femoris,

which makes an obtuse angle with the tibia, they would alone be liable to draw the patella outward. This contrivance is most obvious in those whose knees bend most inward.

Crureus arises between the two last, below the rectus, from all the convex part of the os femoris, and is inserted in like manner into the patella; the patella being tied down by a strong ligament to the tibia. These three last muscles extend the tibia only, and might very properly be called extensor tibiæ triceps.

Gasterocnemius arises by two small beginnings above the back part of the apophysis of the os femoris, which soon becoming large bellies unite, and then become a flat tendon which joins the following muscles to be inserted into the os calcis. The two parts of this muscle are by some writers distinguished into two muscles. Its use is to extend the tarsus and bend the knee.

Plantaris arises under the outer beginning of the last named muscle, from the external apophysis of the os femoris, and soon becoming a small tendon, is so continued betwixt the foregoing and subsequent muscles, and is inserted with them. It bends the knee, and extends the tarsus. Authors derive the tendinous expansion on the bottom of the foot from the tendon of this muscle; but seeing the expansion is much more than this tendon could make, and that this tendon can be traced no farther than the os calcis, and that the expansion is

as large when the muscle is wanting, which is not seldom, I cannot be of that opinion.

Gasterocnemius internus arises from the upper part of the tibia, and one third of the fibula, below the popliteus, and is inserted with the two foregoing muscles by a strong tendon into the upper and back part of the os calcis. This muscle only extends the tarsus.

Tibialis anticus arises from the upper and exterior part of the tibia, and is inserted laterally into the os cuneiforme majus of the tarsus, and by a small portion of its tendon into the metacarpal bone of the great toe. This bends and turns the tarsus inward.

Tibialis posticus arises first by a small beginning from the upper part of the tibia between that bone and the fibula, then passing between the bones through a perforation in the transverse ligament which connects those bones, it takes other beginnings from the upper and middle part of the tibia, and from the middle of the fibula, and the ligament betwixt the tibia and fibula; then growing a round tendon, passes under the inner ancle, and is inserted into the lower part of the os naviculare, and into the os cuneiforme majus. This extends and turns inward the tarsus.

Peroneus longus arises from the upper and outer part of the fibula, and growing a tendon toward the lower part of this bone, passes under the outer ancle, and the muscles situated on the bot-

tom of the foot, and is inserted into the beginning of the metatarsal bone of the great toe, and the os cuneiforme next that bone. This turns the tarsus outward, and directs the force of the other extensors of the tarsus toward the ball of the great toe.

Peroneus brevis arises from the middle of the fibula, under a part of the former, and growing tendinous, passes under the outward ancle, and is inserted into the beginning of the upper part of the os metatarsi of the little toe, and sometimes bestows a small tendon on the little toe. Its use is to extend the tarsus, and turn it outward.

These two last muscles riding over the lower end of the fibula, are often the cause of a sprain in the outer ancle, when they are vehemently exerted to save a fall.

Extensor pollicis longus arises from the upper and middle part of the fibula and the ligamentum transversale, and soon becoming a strong tendon, is inserted into the last bone of the great toe. This also bends the tarsus with a much longer lever than it extends the toe.

Extensor pollicis brevis arises from the fore part of the os calcis, and is inserted into the same place with the former.

Flexor pollicis longus arises from the fibula, opposite to the extensor longus, and then passing under the inner ancle, is inserted into the under side of the last bone of the great toe. This

extends the tarsus at a longer lever than it bends the toe.

Flexor brevis and adductor pollicis are the same muscle, arising from the two lesser ossa cuneiformia and os cuboides and calcis. They are inserted into the ossa sesamoidea, which are tied by a ligament to the first bone of the great toe, reckoning only two bones to the great toe. These muscles bend the great toe.

Abductor pollicis arises pretty largely from the inner and back part of the os calcis, and by a smaller beginning from the os naviculare; thence passing forward contiguous to the os cuneiforme majus, passes by the external sesamoid bone of the great toe to its insertion into the first bone of the great toe. This muscle is less an abductor than a flexor pollicis pedis; it also very much helps to constrict the foot lengthways.

Transversalis pedis arises from the lower end of the metatarsal bone of the toe next the least, and is inserted into the internal sesamoid bone. This truly is an adductor of the great toe, and helps to keep the constricture of the bottom of the foot.

Extensor digitorum pedis longus arises acute from the upper part of the tibia, and from the upper and middle part of the fibula and ligament between these bones; then dividing into five tendons, four of them are inserted into the second bone of each lesser toe, and the fifth into the beginning of the metatarsal bone of the least toe, and

sometimes by a small tendon also into the little toe. This last portion for the most part is separate from its beginning, and may be accounted a distinct muscle. The four first tendons only of this muscle extend the toes, but all five bend the tarsus, and that with a longer lever than any of them bend a toe.

Extensor digitorum brevis, arises together with the extensor pollicis brevis, from the os calcis, and dividing into three small tendons is inserted into the second joint of the three toes next the great one. The long extensors of the toes serve not only to extend them, but also contribute to the bending of the ancle, which motions are usually performed together in progression; but the short extensors arising below the ancle, extend the toes only; and when the long extensors are employed for that action only, the extensors of the tarsus must act at the same time, to prevent the bending of the ancle. This is the reason why the toes have need, though their motions are less, of more extensors than the fingers.

Flexor brevis or perforatus arises from the under and back part of the os calcis, thence passing toward the four lesser toes, divides into four tendons, which are inserted into the beginning of the second bone of each of the lesser toes. These tendons are divided to let through the tendons of the following muscles.

Flexor longus or perforans arises from the back part of the tibia, above the insertion of

the popliteus, and part of the fibula ; thence descending under the os calcis to the bottom of the foot, there becomes tendinous, often crosses, and, in most bodies, communicates with the flexor longus pollicis pedis ; then it divides into four tendons which pass through those of the flexor brevis, and are inserted into the third bone of the four lesser toes. This muscle also extends the tarsus. The second beginning of this muscle arises from the os calcis, and joins the tendons where they divide. This portion only bends the toes : and seeing the flexor longus of the toes will, when it acts alone, extend the tarsus as well as bend the toes, this portion, like the short extensors of the toes, seems purposely contrived to bend the toes alone.

Lumbricales arise from the tendons of the perforans, and are inserted into the first bone of each of the lesser toes which they bend.

Abductor minimi digiti pedis arises by the perforatus from the os calcis, and being part of it inserted into the metacarpal bone of the least toe, it receives another beginning from the os cuboides, and is inserted into the first bone of the least toe, which it bends and pulls outward, and very much helps to constrict the bottom of the foot.

Abductor secundus minimi digiti arises under the former muscle from the metatarsal bone, and is inserted into the little toe.

Interossei are seven muscles which lie like those of the hands, and arise like them from the

metatarsal bones, and are inserted like them into the last joints of the four lesser toes; and being in their progress attached to the tendons, which extend the second joints of the toes, they will extend both these joints. These muscles may be fitly divided into external and internal; the internal also bend the first joints, as do all the interossei in the hand, but here the outer ones extend the first joints; and if we consider that the first of these muscles is analogous to the abductor indicis of the hand, and that the abductor minimi is alike in both, we find that the muscles to move the fingers and lesser toes sideways are alike in number, though this motion of the toes is in a manner lost from the use of shoes. The muscles that bend or extend the last joints of the toes will also move the second and first, and those that move the second will also move the first, as they do in the fingers.

TABLE XI.

1 Musculus frontalis.
2 Temporalis.
3 Orbicularis.
4 The parotid gland, with its duct, which passes through the buccinator.
5 Mastoideus.
6 Zygomaticus.
7 Elevator labii superioris proprius.
8 Elevator labiorum communis.
9 Depressor labiorum communis.
10 Sphincter oris.
11 Depressor labii inferioris proprius.
12 Buccinator.
13 Sterno-hyoidei.
14 Coraco-hyoideus.
15 Mastoideus.
16 Trapezius.
17 Pectoralis.
18 Deltoides.


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TAB. XII.

TABLE XII.

1 Musculus mastoideus.
2 Pectoralis.
3 Biceps flexor cubiti.
4 Coraco-brachialis.
5 Triceps extensor cubiti.
6 Latissimus dorsi.
7 Serator major anticus.
8 Obliquus descendens abdominis.
9 Rectus abdominis.
10 Pyramidalis.
11 Sartorius.
12 Fascialis.
13 Rectus femoris.

TABLE XIII.

1 Trapezius.
2 Deltoides.
3 Infraspinatus scapulæ.
4 Teres major.
5 Rhomboides.
6 Latissimus dorsi.
7 Glutæi.
8 Obliquus descendens abdominis.


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TABLE XIV.

1 Musculus deltoides.
2 Triceps extensor cubiti.
3 Anconæus.
4 Extensor carpi radialis primus.
5 Extensor carpi radialis secundus.
6 Extensor carpi ulnaris.
7 Flexor carpi ulnaris.
8 Deltoides.
9 Biceps flexor cubiti.
10 Brachiæus internus.
11 Triceps extensor cubiti.
12 Supinator radii longus.
13 Extensores carpi radiales.
14 Extensor communis digitorum.
15 Extensor carpi ulnaris.
16 Flexor carpi ulnaris.
17 Anconæus.
18 Extensor pollicis primus.
19 Extensor pollicis secundus.

TABLE XV.

1 Musculus deltoides.
2 Pectoralis.
3 Biceps flexor cubiti.
4 Triceps extensor cubiti.
5 The fascia tendinosa of the biceps muscle.
6 Supinator radii longus.
7 Flexor carpi radialis.
8 Glutæus.
9 Vastus externus.
10 Biceps femoris.
11 Semitendinosus.
12 Semimembranosus.
13 Gastrocnemius.
14 Solæus.


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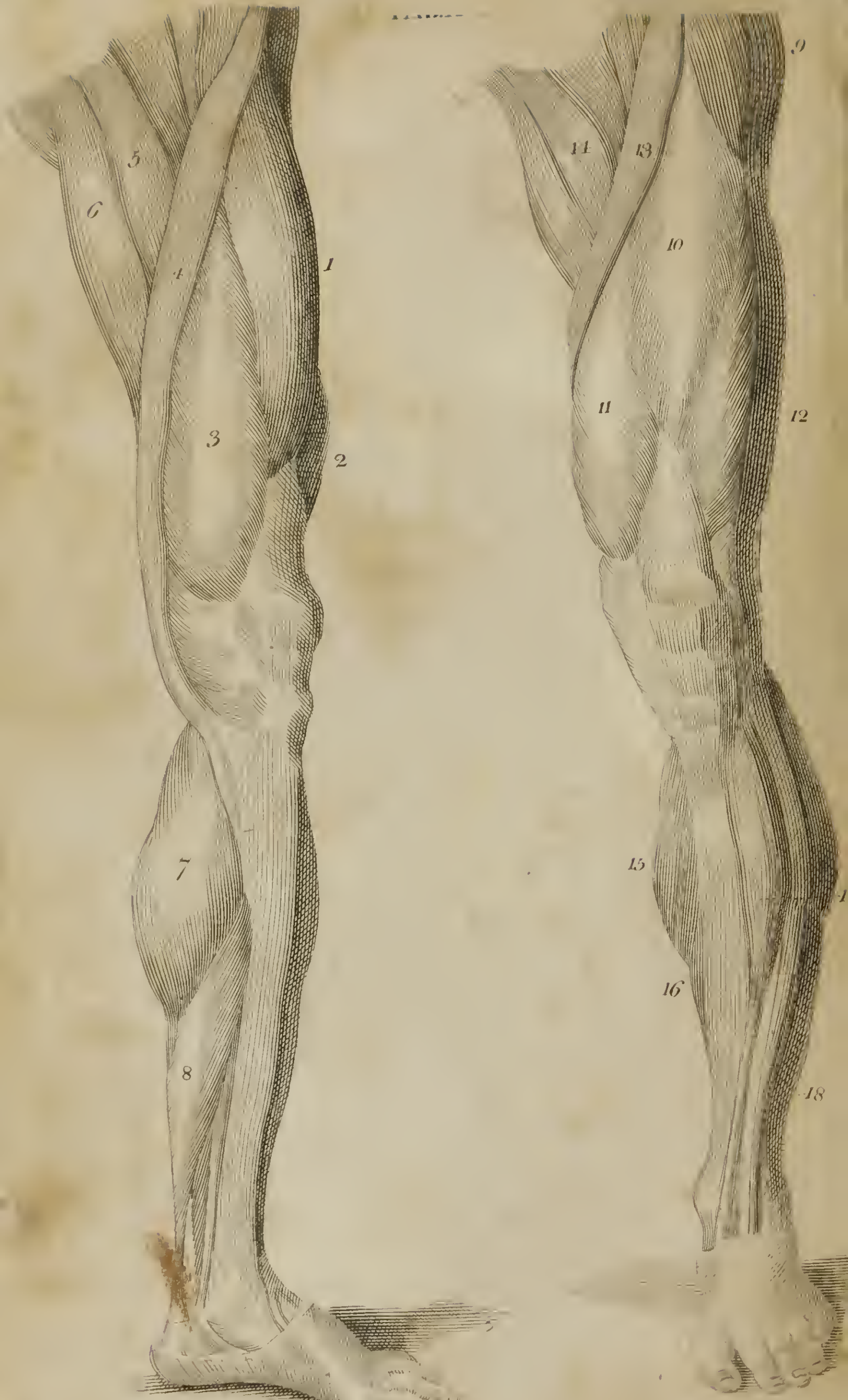

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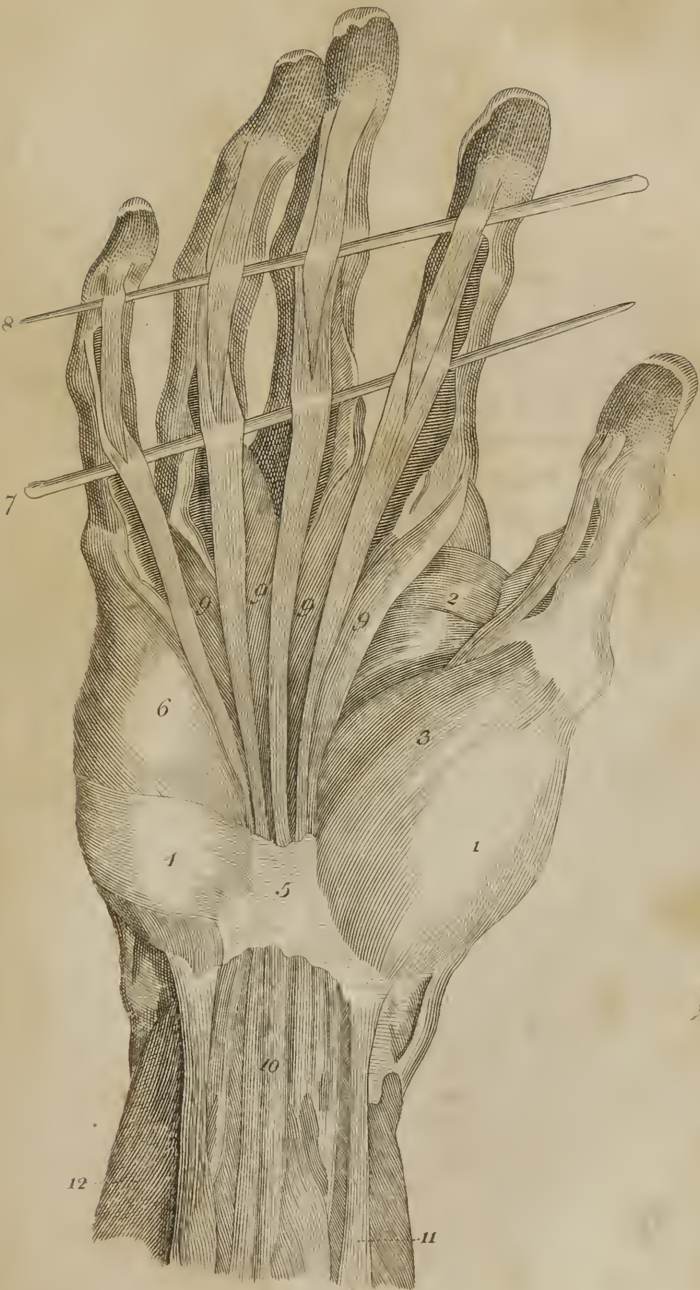
TABLE XVI.

1 Musculus rectus femoris.
2 Vastus externus.
3 Vastus internus.
4 Sartorius.
5 Pectinæus.
6 The large head of the triceps.
7 Gastrocnemius.
8 Solæus.
9 Membranosus.
10 Rectus femoris.
11 Vastus internus.
12 Vastus externus.
13 Sartorius.
14 Pectinæus.
15 Gastrocnemius.
16 Solæus.
17 Tibialis anticus.
18 Extensores digitorum.

TABLE XVII.

1 Musculus abductor pollicis.
2 Adductor pollicis.
3 Flexor brevis.
4 Quadratus seu palmaris brevis.
5 The strong ligament of the carpus that binds down the tendons of the flexors of the fingers.
6 Abductor minimi digiti.
7 A probe under the tendons of the perforatus.
8 A probe under the tendons of the perforans.
9 Lumbricales.
10 Perforatus.
11 Flexor carpi radialis.
12 Flexor carpi ulnaris.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TAB. XVIII.

TABLE XVIII.

1 Tendo achilles.

2 That part of the astragalus which articulates with the tibia.

3 The tendon of the tibialis anticus.

4 The tendon of the extensor pollicis pedis longus.

5 The tendons of the extensor digitorum communis.

6 Extensor pollicis pedis brevis.

7 Extensor digitorum brevis.

8 The union of the tendons of the extensor longus and the extensor brevis.

TABLE XIX.

1 Musculus triceps extensor cubiti.
2 Deltoides.
3 Teres major.
4 Latissimus dorsi.
5 Pectoralis.
6 Obliquus descendens abdominis.
7 Rectus abdominis.
8 Sartorius.
9 Rectus femoris.
10 Vastus externus.
11 Vastus internus.
12 Gastrocnemius.
13 Solæus.
14 Tibialis anticus.


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TABLE XX.

This table is done after the famous statue of Hercules and Antæus. The muscles here exhibited being all explained in the other plates, the figures are omitted to preserve the beauty of the plate.

THE

ANATOMY

OF THE

HUMAN BODY.

BOOK III.

CHAPTER I.

OF THE EXTERNAL PARTS, AND COMMON INTEGUMENTS.

THE vulgar names of the external parts of the human body being sufficiently known for the description of any disease or operation; I shall only describe those which anatomists have given for the better understanding of the sub-contained parts.

The hollow on the middle of the thorax, under the breasts, is called scrobiculus cordis; the middle of the abdomen for about three fingers breadth

above and below the navel, is called regio umbilicalis; the middle part above this, epigastrium; on each side of the epigastrium, under the cartilages of the lower ribs, hypocondrium; and from below the regio umbilicalis, down to the ossa ilia and ossa pubis, hypogastrium.

Cuticula, or scarf-skin, is that thin insensible membrane which is raised by blisters in living bodies. It is extended over every part of the true skin, unless where the nails are. It appears to me in a microscope a very fine smooth membrane, only unequal where the reticulum mucosum adheres to it. LEWENHOECK, and others, say it appears scaly, and compute that a grain of sand of the hundreth part of an inch diameter, will cover two hundred and fifty of these scales, and that each scale has about five hundred pores; so that a grain of sand will cover 125,000 pores through which we perspire. Its use is to defend the true skin that it may not be exposed to pain from whatever it touches; and also to preserve it from wearing; it is thickest on those parts of the bottom of the foot which sustain the body, and in hands much used to labour, being so contrived as to grow the thicker the more those parts are used. In scorbutic disorders the cuticula will sometimes become scurfy and full of little ulcers, which are apt to remain even when the cause is taken away, but the cuticle being taken off by a blister, the new cuticle will be sound; and though the cutis is affected

and full of little tumors, the discharge of the blister will often cure them also.

Between this and the true skin is a small quantity of slimy matter, which was supposed by MALPIGHI and others, to be contained in proper vessels, interwoven with one another, and therefore by them named reticulum mucosum. It is most considerable where the cuticula is thickest, and is black, white, or dusky, such as is the complexion; the colour of this and the cuticula being the only difference between Europeans and Africans or Indians, the fibres of the true skin being white in all men; but the florid colour of the cheeks is owing to the blood in the minute vessels of the skin, as that in the lips to the vessels in the muscular flesh; for the cuticula being made of excrementitious matter, has no blood vessels.

Cutis, or true skin, is a very compact, strong, and sensible membrane, extended over all the other parts of the body, having nerves terminating so plentifully in all its superficies, for the sense of touching, that the finest pointed instrument can prick no where without touching some of them. These nerves are said by MALPIGHI and others, who have examined them carefully, to terminate in small pyramidal papillæ; nevertheless, it seems that a plain superficies of the skin is much fitter and more agreeable to what we experience of this sensation; for a plain superficies exposing all the nerves alike, I think, would give a more equal

sensation, while nerves ending in a pyramidal papilla would be exceeding sensible at the vertex of that papilla; and those at the sides and round the base, which would be far the greatest part, would be the least useful. Immediately under the skin upon the shin bone, I have twice seen little tumors less than a pea, round and exceeding hard, and so painful that both cases were judged to be cancerous; they were cured by extirpating the tumor: but what was more extraordinary, was a tumor of this kind, under the skin of the buttock, small as a pin's head, yet so painful that the least touch was insupportable, and the skin for half an inch round was emaciated; this too I extirpated, with so much of the skin as was emaciated, and some fat. The patient, who before the operation could not endure to set his leg to the ground, nor turn in his bed without exquisite pain, grew immediately easy, walked to his bed without any complaint, and was soon cured.

Glandulæ miliares are small bodies like millet seeds, seated immediately under the skin in the axillas; and are said to have been found under all other parts of the skin, where they have been looked for with microscopes. These glands are supposed to separate sweat; which fluid was thought to be only the materia perspirabilis flowing in a greater quantity, and condensed, till SANCTORIUS assured us that it is not so, and that more of the materia perspirabilis is separated in equal times than

of sweat; of the former, he says, usually fifty-two ounces a day in Italy, where his experiments were made, and of the latter not near so much in the most profuse sweats; which seems to favour the opinion of the existence of these glands: but whoever reads Mr. HALES's experiments will find, that what SANCTORIUS accounted for by an imaginary insensible perspiration, different from that which in the greatest degree produces sweat, is really made by the lungs in respiration, and is ten times more than all the ordinary perspiration through the cutis, and seems to be but the same kind of fluid discharged both ways; for whenever it is interrupted through the skin in cold weather, then the lungs are overcharged, which occasions coughing to get rid of it, which in a greater degree is an asthma. Hence too it is, that those who perspire most in the summer are most subject to asthmatic disorders in the winter; and most of all so, when the air they breathe is fullest of vapour, and therefore least capable of conveying this matter from the lungs. That this kind of perspiration is very great, is sufficiently shewn by breathing upon glass, or any thing that is smooth and cold.

Membrana adiposa is all that membrane immediately under the skin, which contains the fat in cells; it is thickest on the abdomen and buttocks, and thinnest nearest the extremities; and where the muscles adhere to the skin, and on the

penis, little or none. It contributes to keep the inner parts warm, and by filling the interstices of the muscles, renders the surface of the body smooth and beautiful, and may serve to lubricate their surfaces. Whether the decrease of fat, which often follows labour or sickness, proceeds from its being reassumed into the blood vessels, or whether it is constantly perspiring through the skin, and the lessening of its quantity is from the want of a supply equal to its consumption, is with me a matter of doubt, though the former opinion, I know, generally prevails. The cells of this membrane communicate throughout the whole body so much, that from any one part the whole may be filled with air. I have seen two cases where the wind-pipe being cut, and the external wounds being closely stitched by injudicious surgeons, the air that escaped at the wound of the wind-pipe getting into the cells of the membrana adiposa, blew up the upper part of the body like a bladder. The like accident I have seen from a broken rib, where, I suppose, the end of the rib had pricked the lungs; all these persons died. In these cells the water is contained in an anasarca, which from its weight, first fills the depending parts, as the air in the former cases did the upper parts; and when these cells are very full, the water frequently passes from them into the abdomen, and after tapping, though the limbs were ever so full, they will almost empty themselves in one night's

time. This membrane is the usual seat of imposthumations and boils, in both which nature, uninterrupted, always corrodes a hole in the skin; from whence we may learn, that the best way of opening any imposthumation is by a hole, and that too as near the time of its breaking naturally as may be, that nature may make the utmost advantage of the discharge. There is sometimes a large kind of boil or carbuncle in this membrane, which first makes a large slough and a number of small holes through the skin, which in time mortifies and casts off, but the longer the slough is suffered to remain, the more it discharges, and the more advantage to the patient; at the latter end of which case the matter has a bloody tincture, and a bilious smell, exactly like what comes from ulcers in the liver; and both these cases are attended with sweet urine, as in a diabetes.

Mammæ, the breasts, seem to be of the same structure in both sexes, but largest in women. Each breast is a conglomerate gland to separate milk, with its excretory ducts; which are capable of very great distention, tending toward the nipple, which as they approach, they unite, and make but a few ducts at their exit. There are to be met with in authors instances attested of men giving suck, when they have been excited by a vehement desire of doing it: and it is a common observation, that milk will flow out of the breasts of new-born children, both male and female.

The breasts and uterus in women, the tongue, mouth, and penis in men, and the eyes in children, are the parts most subject to cancers; yet there is no part where this disease has not sometimes fixed. It is a matter of dispute among some surgeons, whether cancerous tumours should ever be extirpated or not, though it is certain none of these ever were cured without, and being extirpated, there have been many. The objection against extirpation is this, that the operation often provokes the part, which otherwise might lie quiet: but I do not think this is true; in desperate cases, where we cannot extirpate, we find the best remedy is plentiful bleeding, (which also is nature's last resort) gentle constant evacuations by stool, and a vegetable diet; and though physic never cures while the tumour remains, yet after extirpation it is highly useful, and even the worst constitutions have sometimes been brought to their primitive state. An eminent surgeon in the city, having a patient with a cancerated breast, extremely large, and so much ulcerated that the stench of it was insupportable; she insisted upon the extirpation, against all advice, with no other hopes but to be delivered from the offensive smell. Some time after the operation, the wound looking extremely sordid, he sprinkled it all over with red mercury precipitate, which put the patient into a high salivation, upon which the breast grew clean and healed, the patient recovered, and, contrary to all expectation, lived many

years in good health. From this accident I learnt the usefulness of salivating, after extirpating cancerous tumours, though nothing is more hurtful before. In the extirpation of a breast, and all other tumours, as much skin as is possible should be saved; for the loss of a great deal of skin is sufficient to make an incurable ulcer in the most healthful body, and much more so in a bad constitution.

CHAPTER II.

OF THE MEMBRANES IN GENERAL.

EVERY distinct part of the body is covered, and every cavity is lined with a single membrane, whose thickness and strength is as the bulk of the part it belongs to, and as the friction to which it is naturally exposed.

Those membranes that contain distinct parts, keep the parts they contain together, and render their surfaces smooth, and less subject to be lacerated by the actions of the body; and those which line cavities serve to render the cavities smooth, and fit for the parts they contain to move against.

The membranes of all the cavities that contain solid parts, are studded with glands, or are provided with vessels, which separate a mucus, to make the parts contained move glibly against one another, and not grow together; and those cavities which are exposed to the air, as the nose, ears, mouth,

and trachea arteria, have their membranes beset with glands which separate matter to defend them from the outer air. Those membranes that have proper names, and deserve a particular description, will be treated of in their proper places.

CHAPTER III.

OF THE SALIVARY GLANDS.

PAROTIS, or maxillaris superior, is the largest of the salivary glands; it is situate behind the lower jaw, under the ear; its excretory duct passes over the upper part of the masseter muscle, and enters the mouth through the buccinator. This gland has its saliva promoted by the motions of the lower jaw. Its duct passes over the tendinous part of the masseter muscle, that it may not be compressed by that muscle, which would obstruct the saliva in it, though it is frequently said that it passes over that muscle that it may be compressed by it, to promote the saliva. In sheep, horses, &c. whose jaws are long, this muscle is inserted far from the centre of motion, that the end of the jaw may be moved with sufficient strength, and that distant insertion requiring a greater length of muscle, that its motion may be quick enough, no part of this muscle could be allowed to be tendinous; therefore, it seems, to avoid the inconve-

nience of compression from the muscle, the duct in those animals goes quite round the lower end of it. When this duct is divided by an external wound, the saliva will flow out on the cheek, unless a convenient perforation be made into the mouth, and then the external wound may be healed. I have seen patients with this gland ulcerated, from which there was a constant effusion of saliva, till the greatest part of the gland was consumed with red mercury precipitate; and then they healed with little trouble. Hildanus mentions the same case, which for two years had been under the care of a surgeon without success; and was at last cured by the application of an actual cautery.

Maxillaris inferior is situate between the lower jaw and the tendon of the digastric muscle. Its duct passes under the musculus mylohyoideus, and enters the mouth under the tongue, near the dentes incisorii. I was at the opening of a woman who was suffocated by a tumour which begun in this gland, and extended itself from the sternum to the parotid gland on one side in six weeks time, and in nine weeks killed her; it was a true scirrhus, and weighed twenty six ounces. In a man which I dissected, I found a quantity of pus near this gland, and a bundle of matter not unlike hair, as large as an hen's egg.

Sublingualis is a small gland situated under the tongue, between the jaw and the seratoglossus muscle. In a calf I found several ducts of this

gland filled by an injection into the duct of the submaxillary gland; but MORGAGNI and others shew, that the ducts of this gland enter the mouth directly from the gland in several places near the grinding teeth.

Tonsilla is a globular gland, about the bigness of a hazel nut, situate upon the pterygoideus internus muscle, between the root of the tongue and the uvula. It has no duct continued from it, but empties all its small ducts into a sinus of its own, which sinus, when the gland is inflamed, may easily be mistaken for an ulcer. This gland with its fellow direct the masticated aliment into the pharynx, and also serve for the uvula to shut down upon when we breathe through the nose. They are compressed by the tongue and the aliment, when the former raises the latter over its root, and thereby opportunely emit their saliva to lubricate the food for its easier descent through the pharynx. A scirrhous tumour of either of these glands is a common disease, and it admits of no remedy but extirpation. The best way of extirpating them, is, I think, by ligature: if the gland is small at its basis, the ligature may be tied round it, which I have often performed by fixing the ligature to the end of a probe bent, and so drew it round the gland, and tied it; and in a few days the glands dropped off: but meeting with other cases of this kind, where the basis of the gland was too large to tie, I contrived an instrument like a crooked needle

set in a handle, with an eye near the point; I thrust this instrument, with a ligature into it through the bottom of the gland, and then taking hold of the ligature with a hook, I drew back the instrument; then drawing the double ligature forwards, I divided it, and tied one part above and the other below, in the same manner that I did to extirpate part of the omentum in the cure of an hernia, and this succeeded as well as the former. See the plate at the latter end of this book.

Pressure upon the surface of a gland very much promoting the secretion that is made in it, these glands are so seated as to be pressed by the lower jaw, and its muscles, which will be chiefly at the time when the fluid is wanted; and the force with which the jaw must be moved, being as the dryness and hardness of the food masticated, the secretion from the glands depending very much upon that force; it will also be in proportion to the dryness and hardness of that food which is necessary; for all food, being to be reduced to a pulp, by being broke and mixed with saliva, before it can be swallowed fit for digestion, the drier and harder foods needing more of this matter, will from this mechanism be supplied with more than moister foods in about that proportion in which they are drier and harder; and the drier foods needing more saliva than moister, is the reason why we can eat less, and digest less of these than those. What quantity of saliva these glands can separate

from the blood, in a given time, will be hard to determine, but in eating of dry bread it cannot be less than the weight of the bread; and many men, in a little time, can eat more dry bread than twice the size of all these glands; and some, that are not used to smoking, can spit half a pint in the smoking one pipe of tobacco; and some men in a salivation, have spit, for days or weeks together, a gallon in four and twenty hours; and yet, I believe, all these glands put together, do not weigh more than four ounces.

The membrane which lines the mouth and palate, and covers the tongue, is every where beset with small glands, to afford saliva in all parts of the mouth to keep it moist; for those more remote are chiefly concerned in time of mastication. These small glands have names given them according to their respective situations, as buccales, labiales, linguales, fauciales, palatinæ, gingivarum, and uvulares.

A gland is chiefly composed of a convolution of one or more arteries of a considerable length, from whose sides arise a vast number of excretory ducts, as the lacteals arise from the guts, to receive in each gland their proper juices, as the lacteals do the chyle; and though the larger secretions are made by visible glands, yet unconvolved arteries may also have excretory ducts for the same purpose. And this way, I imagine, secretions are made from all the membranes that line cavities, and some others.

There also arise from these arteries lymphatic vessels, whose use seems to be to take off the thinnest part of the blood, where a thick fluid is to be secreted, seeing they are found in greatest plenty in such glands as separate the thickest fluids, as in the testicles and liver ; and it is observable that, where the thickest secretions are made, the velocity of the blood is the least, as if it was contrived to give those seemingly more tenacious parts more time to separate from the blood. The arteries that compose different glands are convolved in different manners ; but whether or no their different secretions depend at all upon that, I doubt will be difficult to discover. The excretory ducts arise from the arteries, and unite in their progress, as the roots of trees do from the earth ; and as different trees, plants, fruits, and even different minerals, in their growing, often derive their distinct, proper, nutritious juices from the same kind of earth ; so the excretory ducts, in different glands, separate from the same mass of blood their different juices : but what these different secretions depend upon, whether the structure of the parts, or different attractions, or what else, we have no certainty about, though this subject has employed several ingenious writers. For my own part, from the great simplicity and uniformity usually seen in nature's works, I am most inclined to think different secretions arise from different attractions, seeing that in plants and minerals there seems to be no other way.

CHAPTER IV.

OF THE PERITONÆUM, OMENTUM, DUCTUS ALIMENTALIS, AND MESENTERY.

PERITONÆUM is a membrane which lines the whole cavity of the abdomen. It contains the liver, spleen, omentum, stomach, guts, and mesentery, with all their vessels and glands; the upper part of it is no other than the próper membrane of the diaphragm, for there is no more reason to call that, part of the peritonæum, than there is for calling the membrane on the other side of the diaphragm, part of the pleura or mediastinum. The fore part next the muscles of the abdomen, and their tendons, may be divided into two laminæ, yet, I think, anatomists in describing the duplicature or laminæ of the peritonæum have not always meant this division, but have taken the tendons of the transverse muscles for the outer lamina, and considered the other as one membrane, seeing that it is between these tendons and the peritonæum that the water is found in that kind of dropsy which is called the dropsy in the duplicature of the peritonæum. Upon the loins the inner surface only is smooth, and the outer part a sort of loose membrana adiposa, in which are contained the aorta, vena cava, vasa spermatica, and pancreas, with other parts of less note. The middle of the peritonæum upon the loins is joined to the mesentery

in such a manner, as makes some account it a production of the peritonæum, and some part of the external membrane of the duodenum, becoming one membrane with the inner or smooth lamina of the peritonæum, and part of the rectum is covered in the same manner; but the kidneys and bladder of urine are contained in a distinct duplicature of this membrane. The dropsy of the peritonæum may be distinguished by being least prominent about the navel, for there the tendons and the peritonæum will not separate; and the water in those that I have dissected, had made the parts where it was contained as foul as any ulcer; therefore none of them, I presume, could have been cured by operation.

For the umbilical vessels, see chap. Of the fœtus. For the processus vaginalis, chap. Of the parts of generation in men.

Omentum, or caul, is a fine membrane, larded with fat, somewhat like net-work. It is situated on the surface of the small guts, and resembles an apron tucked up; its outer or upper part, named ala superior, is connected to the bottom of the stomach, the spleen, and part of the intestinum duodenum; and thence descending a little lower than the navel, is reflected and tied to the intestinum colon, the spleen, and part of the duodenum; this last part is called ala inferior; and the space between the alæ is named bursa. This cavity is very distinct in most brutes, but seldom so in

men. Sometimes both alæ are tied to the liver, and, in diseased bodies, to the peritonæum. Its use is to lubricate the guts, that they may the better perform their peristaltic motion. MALPIGHI describes adipose ducts in this membrane to carry the fat from the cells into the vena portæ, and thinks it a necessary ingredient in the bile. In dropsies of the abdomen, and in persons who from any other cause have died tabid, it is generally rotten and decayed; and sometimes the guts in these cases adhere to one another: but whether these adhesions proceed from the omentum's ceasing to perform its office, or from the peristaltic motion of the guts being long discontinued through abstinence, or both, I cannot determine.

Ductus alimentalis, is the œsophagus, stomach, and guts, viz. duodenum, jejunum, ilium, colon, cæcum or appendicula vermiformis, and rectum.

Œsophagus, or gullet, is the beginning of the alimentary duct; its upper part is wide and open, spread behind the tongue to receive the masticated aliment; it begins from the basis of the scull, near the processus pterygoides of the sphenoidal bone, then descending becomes round, and is called vaginalis gulæ; it runs from the tongue close to the spine, under the left subclavian blood vessels, into and through the thorax on the left side, then piercing the diaphragm, it immediately enters the stomach. It is composed of a thin outer coat, which is no

more than a proper membrane to the middle or muscular coat. The middle coat is composed of longitudinal and circular muscular fibres, but chiefly circular, abundantly thicker than the same coat in the guts; because this has no foreign power to assist it, as the guts have, and because it is necessary the food should make a shorter stay here than there. The inner coat is a pretty smooth membrane, beset with many glands, which secrete a mucilaginous matter, to defend this membrane, and render the descent of the aliment easy.

Ventriculus, the stomach, is situated under the left side of the diaphragm, its left side touching the spleen, and its right is covered by the thin edge of the liver; its figure nearly resembles the pouch of a bagpipe, its left end being most capacious, the upper side concave, and the lower convex: it has two orifices, both on its upper part; the left, through which the aliment passes into the stomach, is named cardia; and the right, through which it is conveyed out of the stomach into the duodenum, is named pylorus; where there is a circular valve which hinders a return of aliment out of the gut, but does not at all times hinder the gall from flowing into the stomach.

The coats of the stomach are three; the external membranous, the middle muscular, whose fibres are chiefly longitudinal and circular, the inner membranous, and beset with glands, which separate a mucus. This last coat is again divided

by anatomists into a fourth, which they call villosa. As the muscular coat of the stomach contracts, the inner coat falls into folds, which increase as the stomach lessens, and consequently retard the aliment most when the stomach is nearest being empty.

The manner in which digestion is performed has been matter of great controversy. The ancients generally supposed the food concocted by a fermentation in the stomach; but the moderns more generally attribute it to the muscular force of the stomach; which Dr. PITCAIRNE has computed to be equal to a hundred and seventeen thousand and eighty eight pounds weight; to which being added the absolute force of the diaphragm and abdominal muscles (but for what reason I am at a loss to conceive, when so small a part of that force can be exerted this way) the sum then will be more than twice as much; a force indeed equal to the end for which he assigns it. Now this force of the muscular coat of the stomach is near forty times greater than what BORELLI has assigned to the heart, which is much stronger; and Dr. KEIL has undertaken to prove, that the force which the heart exerts is not thrice as many ounces as BORELLI computes it to be thousand pounds weight. Yet this is as certain, as that action and reaction are the same; that the abdominal muscles and the diaphragm compress the stomach with no greater force than they do the liver and all other parts contained in the abdomen; and that the fœtus in utero, and all the

viscera in the abdomen, receive much more of this force, during the time of gestation; and yet neither the fœtus, nor any other contained part, is digested by that force; and for the force with which the stomach itself acts, it will be just the same with the reaction of the food upon it, and therefore should be as much more liable to be digested by this and the other force, than the food, as it oftener feels these forces than that (only that living bodies are not so liable to digestion as dead ones:) besides, it may be demonstrated, that the force with which the stomach compresses any part of its contents, is not greater than what is given to equal parts of the contents in the small guts; for if the moment of a muscle is as its weight, and if the muscular coat of the stomach does not bear a greater proportion to the muscular coat of a small gut, than their diameters bear; a section of the stomach having so many more equal parts to press than a like section of a gut, it will require just so much more force to give each part the same pressure. Dr. DRAKE has supposed, that digestion is performed in the stomach, as in PAPIN's Digester; in which hypothesis are contained all the absurdities of that of PITCAIRNE, with this addition, that the stomach must be as irresistible to distention at that time, as his iron pot, and the orifices as forcibly secured; but then indeed it shews how bits of bones, which dogs swallow, may be retained in the stomach without tearing it; which difficulty, in my opinion, Dr. PIT-

CAIRNE has not sufficiently accounted for, though it is none of the least in his hypothesis. In granivorous birds, where digestion is made by muscular force, their second stomach is plainly contrived for comminuting or digesting their food that way; for besides that it is one of the strongest muscles in their bodies, its inside is defended with a hard and strong membrane that it may not be torn; and these birds always eat with their grain the roughest and hardest little stones they can find, which are necessary for grinding their food, notwithstanding it is first soaked in another stomach, and is also food of very easy digestion. In serpents, some birds, and several kinds of fish, which swallow whole animals, and retain them long in their stomachs, digestion seems to be performed by a menstruum; for we frequently find in their stomachs animals so totally digested, before their form is destroyed, that their very bones are made soft. In horses and oxen, digestion is but little more than extracting a tincture; for in their excrements, when voided, we see the texture of their food is not totally destroyed, though grass, in particular, seems to be as easily divided as any food whatever, and the corn they eat is often voided entire: and in the excrements of men, are often seen the skins of fruits undigested, and small fruits, such as currants, unbroke, and worms also continue unhurt, both in the stomach and guts. Therefore, by comparing our stomachs with those here mentioned, it appears to me, that our digestion

is performed by a menstruum, which is chiefly saliva, gently assisted by the action of the stomach, and the abdominal muscles, and by that principle of corruption which is in all dead bodies. For digestion is no other than corruption or putrefaction of our food; therefore meats preserved from corruption by salt or spirits, are hard of digestion and unwholesome. Nevertheless, when this digesting menstruum of the stomach is too crude, the same salts or spirits, moderately used, become a remedy; and though meat long salted is so very unwholesome, it seems not to be from the salt itself, but the meat made undigestible by being long salted; for those who eat the greatest quantity of salt at their meals are not subjected thereby to the same distempers. And this digesting menstruum, when the stomach is empty, exciting that uneasiness which we call hunger, our appetites and our digestion are thereby necessarily suited both as to time and quantity.

Duodenum is the first of the three small guts; it begins from the pylorus of the stomach, and is thence reflected downward; it first passes by the gall bladder, and then under the following gut and mesentery, and coming in sight again in the left hypochondrium, it there commences jejunum, which is the second of the small guts; but the place where this ends and the other begins is not precisely determined.

Jejunum is so called from its being found, for the most part, empty; it is situated in the regio umbilicalis, and makes somewhat more than a third part of the small guts. It is distinguished from the following gut by its coats, which are a small matter thinner and less pale.

Ileum is the continuation of the former, situated in the hypogastrium, and very often some part of it in the pelvis of the abdomen, upon the bladder of urine, especially in women; it enters the colon on the right side, near the upper edge of the os ilium. This great length of the small guts is evidently for the convenience of a greater number of lacteals, that the chyle which misses their orifices in one place may not escape them in another; but those animals which swallow their food whole, and have it a long time in their stomach and guts, have shorter guts and fewer lacteals. Colon is the first of the great guts; it begins at the upper edge of the right os ilium; thence ascending passes under some part of the liver, and the bottom of the stomach, from the right hypochondrium to the left, and thence descends to the pelvis of the abdomen.

Cæcum, or appendicula vermiformis, is situated on the beginning of the colon: it is less than an earth worm, with a small orifice opening into the colon; this gut has seldom any thing in it. In men it is called one of the large guts, though it is the smallest by far; but the mistake

arises from copying the ancients, whose descriptions of all the parts contained in the abdomen, seem to be taken from dogs; for in them, and in many other animals, it is very large: and some fish have them in great numbers, but very small; I have counted in a mackerel above one hundred and fifty.

Rectum is the continuation of the colon through the pelvis to the anus. The lower end of this gut is the seat of the true fistula in ano, which usually runs betwixt the muscular coat and the inner coat; it is cured by opening it the whole length into the cavity of the gut; it is yet better, if it can be done, to extirpate all that is fistulous and scirrhous, for that is a sure way to make one operation perfect the cure. The other kind of fistula, improperly so called, is an abscess running round the outside of the sphincter, in the shape of a horse-shoe, being a circle all but where this muscle unites with those of the penis; this is best cured by opening and removing part of the outer skin. The first of these cases happens oftenest in full habits, proceeding frequently from the piles; the last is generally a critical discharge, and one of nature's last efforts in consumptive and scorbutic habits of body. The inversion and sliding down of this gut is called prolapsus ani, a disease common in children, especially those who are afflicted with the stone, and of not much consequence; in men it is more rare and more dangerous, being generally attended with a flux of humours. This case I have cured by taking away a

piece of the prolapsed gut with a caustic, lengthways of the gut; the wound discharged the flux of humours, upon which the gut was easily reduced, and cicatrising in that state, it never more fell down.

I have seen a case, where a bold unthinking surgeon having cut off the prolapsed part, the cicatrix was so hard and contracted that the patient could never after go to stool without a clyster, and then not without great misery.

Oftentimes the piles occasion large tumours at the lower end of this gut; these are always best extirpated by ligature; for if they are cut, they will sometimes bleed excessively, and it is no easy matter to apply any thing to stop a flux of blood in that part.

The guts have the same coats with the stomach; the fibres of their middle or muscular coat are circular, or spiral, and longitudinal; of the latter but very few. The antagonists to these muscular fibres of the stomach and guts, are their contents pressed from one place to another, and the muscles of the abdomen, for these pressing upon them alter their form into one less capacious; which necessarily extends their circular fibres. The great guts have three membranes, or ligaments, on the outside, running their whole length, and supporting the sacculi, into which those guts are divided. The lesser guts have, at very small distances, semilunar valves placed opposite to the interstices of each other, to prevent the aliment from passing too speedily through the

guts; and the better to answer that end, they are larger and more numerous near the stomach, where the food is thinner, than they are towards the colon, where the food is continually made thicker in its progress, by a discharge of part of the chyle. This contrivance, so necessary to men, because of their erect posture, when they are obliged, by sickness or accidents, to lie along, becomes a great inconvenience, and calls for the help of clysters and purges. But brutes have not these valves, because they are not convenient in an horizontal posture. At the entrance of the ileum into the colon, are two very large valves, which effectually hinder the regress of the fœces into the ileum. But clysters have been frequently known to pass them, and be vomited up; though the excrement that is sometimes vomited up, I am inclined to think, is such as had not passed into the great guts. The other valves in the colon are placed opposite, but not in the same plane, to each other, and make, with their anterior edges, an equilateral triangle; but as the gut approaches the anus, they become less remarkable, and fewer in number.

All the guts have in their inner membrane an almost infinite number of very small glands: these glands will, especially some of them in the large guts, appear to the naked eye when they are diseased: they are called glandulæ pyerianæ.

The length of the guts to that of the body is as five to one in a middle sized man; in taller men

the proportion is usually less, and in short men greater.

Mesentery is a membrane beginning loosely upon the loins, and is thence produced to all the guts: it preserves the jejunum and ileum from twisting in their peristaltic or vermicular motion, and confines the rest to their places. It sustains all the vessels going to and from the guts, viz. arteries, veins, lymphæducts, lacteals and nerves, and also contains many glands, called, from their situation, mesentericæ. The beginning of this membrane from the loins, is about three or four inches broad, but next the guts of the same length with the side of the guts they adhere to, which is in the small guts, about a fourth part shorter than the other side; but when this membrane is separated from the small guts, it shrinks, and measures about two thirds less.

I opened a boy, about twelve years old, that died of the iliac passion, vulgarly called the twisting of the guts; the guts, stomach, duodenum, and jejunum were distended, with vapour and air, to near ten times their natural capacity, which so compressed the intestinum ileum, that nothing could pass through it. The relations of this boy could give no other account of the cause of this disease, than that of his having eaten a large quantity of raw young carrots. This case happens very frequently to lambs that have been housed, and turned out early in the spring to grass, when the grass is very rank and succulent; and also to horses, oxen,

and sheep, when they happen to feed, by any accident, upon young beans or peas, or rich clover grass, which are very apt to ferment in their stomachs. In these animals this case is commonly cured by running a knife into their guts; some instances of which I have seen, and have heard a great many reported; but this case happening very rarely to men, I believe that practice has never yet been used; though the instrument which is used for tapping in a dropsy of the abdomen, might do it with great ease and safety. Some anatomists, who have considered the impossibility of a twisting of the guts, which is the vulgar name of this disease, have imagined that it proceeded from one gut being involved in another. These involutions are found frequently in bodies that die a natural death, and without any inflammation, or any other symptom of pain.

CHAPTER V.

Of the liver, gall-bladder, pancreas and spleen.

THE liver is the largest gland in the body; of a dusky red colour. It is situated immediately under the diaphragm in the right hypochondrium; its exterior side is convex, and interior concave; backward toward the ribs it is thick, and thin on its fore part, where it covers the upper side

of the stomach, and some of the guts; the upper side of it adheres to the diaphragm, and is also tied to it and the sternum by a thin ligament, which is described commonly as two; the upper part called suspensorium, and the anterior latum: but either of these names is sufficient for it all. It is also tied to the navel by a round ligament called teres or umbilicale, which is the umbilical vein degenerated into a ligament; it is inserted into the liver at a small fissure in its lower edge. The ligamentum latum, or suspensorium, sustains the liver in an erect posture, or rather fixes it in its situation, while it is supported by the other viscera, they being compressed by the abdominal muscles; in lying down the teres prevents it from pressing on the diaphragm; and in lying on the back, they both together suspend it, that it may not compress and obstruct the ascending vena cava. It is nourished by the branches of the celiac and mesenteric arteries in the liver, called arteriæ hepaticæ, but its blood vessels, that compose it as a gland, are the branches of the vena portæ, which enters the liver, and distributes its blood like an artery, to have the bile secreted from it; and the branches of the cava in the liver, which return the redundant blood into the cava ascendens: it has also several branches of nerves, and a great number of lymphatics; of which I shall treat in their respective places. Dogs and cats, and other animals, that have a great deal of motion in their backs, have their livers divided into many distinct

lobules; which, by moving one against another, comply with those motions, which else would break their livers to pieces.

The gall-bladder is a receptacle of bile, seated in the hollow side of the liver; it is composed of one dense coat somewhat muscular, which is covered with a membrane like that of the liver; and is also lined with another, that cannot easily be separated. Modern anatomists have described a number of small ducts leading from the liver to the gall-bladder, by which they suppose the gall-bladder is filled; and these I thought I had seen in a human body that died of a jaundice, when I was a very young anatomist; but never being able to see any since in any animal, though I have made very diligent inquiry by experiments and dissection, I am now persuaded that there are no such ducts; for if they are too little to be seen or filled by injections, I think they are too little for the end for which they are assigned. As to the argument for the existence of such ducts, which is fetched from the difficulty of the gall-bladder's being filled through the ductus cysticus from the ductus hepaticus, I think it is of little weight, seeing the vesiculæ seminales are filled with a thicker fluid through a less direct passage. From the gall-bladder towards the duodenum runs a duct called cysticus; and from the liver to this duct one called hepaticus, which carries off the gall this way, when the gall-bladder is full; then the ductus cysticus and hepaticus

being united, commence ductus communis choledochus, which enters the duodenum obliquely about four inches below its beginning. The orifice of this duct in the gut is somewhat eminent, but has no caruncle, as is commonly said. As the liver from its situation in the same cavity with the stomach, will be most pressed, and consequently separate most gall when the stomach is fullest, which is the time when it is most wanted; so the gall-bladder, being seated against the duodenum, it will have its fluid pressed out by the aliment passing through that gut, and consequently at a right time and in due proportion; because the greater that quantity of aliment is, the greater will be the compression; and so the contrary.

I know no way of computing, with any exactness, the quantity of bile that is usually secreted by the liver in a given time; but if it is four times as much as all the salivary glands secrete, it may be twenty four ounces for every meal: to which being added six ounces of saliva, which, from what is observed in the chapter of the salivary glands, I think will appear a moderate computation: and supposing the pancreas in the same time secretes three ounces, there will then be thirty three ounces of fluids separated for the digestion of one meal; and that these necessary fluids may not be wasted in such quantities, they pass into the blood with the chyle, and may be soon separated again for the same use; and very likely, some of the same bile

may be employed more than once, for digesting part of the same meal; and as the liver exceeds all the glands in the body in magnitude, and its excretory ducts ending in the duodenum, it seems to me to be much more capable of making those large separations from the blood, which are procured by cathartics, than the scarce visible glands of the guts. The liver ordinarily weighs, in a middle sized man, about three pounds twelve ounces, the pancreas three ounces, and the spleen fourteen ounces. I have seen a diseased liver in a man that weighed fourteen pounds four ounces: and in a boy but nine years old, that died hydropic, the liver full of hydatids, and cysts of hydatids adhering to it, which together weighed seven pounds one ounce and a half, though several pints of water had been let out of it before. The spleen in the same boy, together with the hydatids contained in its membrane, weighed three pounds. In a man I found a diseased spleen, weighing five pounds two ounces; and in an old man, six feet high, I found a sound liver weighing no more than twenty eight ounces, and the spleen but ten ounces: and in a man that had been cured of a dropsy I found a polypus very solid, almost filling the large branches of the porta in the liver, and a stone between the liver and gall-bladder, larger than a nutmeg.

Pancreas, the sweet bread, is a large gland of the salivary kind, lying across the upper and back part of the abdomen, near the duodenum; it

has a short excretory duct, about half as large as a crow quill, though it is commonly painted as large as the ductus communis choledochus: it always enters the duodenum together with the bile duct; but in dogs some distance from it; and, I think, always in two ducts distant from one another. The juice of this gland, together with the bile, helps to complete the digestion of the aliment, and renders it fit to enter the lacteal vessels. In a man that died of a jaundice, I found the ductus communis choledochus constricted by a scirrhous pancreas, the gall-bladder extended to the size of a goose egg, and all the ducts to twice their natural bigness. This is the case in which I thought I had so plainly seen the cystihepatic ducts: I once saw the ductus cysticus obstructed, without the gall-bladder being distended, which, I think, furnishes us with a very probable argument against the existence of cystihepatic ducts. In those who die of the jaundice, for the most part are found in the gall-bladder and the biliary ducts concretions of bile so light as to swim in water, yet are called gall stones: these cause the jaundice, by obstructing the ducts: many of those who have been cured of this disease, have had great numbers of these stones found in their excrements. A patient of mine, who had voided by stool several of these stones, had afterwards two of half an inch diameter, which made their way through the integuments of the abdomen, and was cured without much pain. Oxen, as the same gen-

tleman informed me, who have been long fed upon rymeat, abound with them; while others, fed with them, and afterwards turned to grass, when killed, are found without them. This gentleman could never eat any herbs. He also informed me of a physician in France, that with great reputation cured the jaundice by giving his patients large quantities of the juice of herbs.

The spleen is seated in the left hypochondrium, immediately under the diaphragm, and above the kidney, between the stomach and the ribs; it is supported by the subcontained parts, and fixed to its place by an adhesion to the peritonæum and diaphragm; it is also connected to the omentum, as has been observed. The figure of it is a sort of depressed oval, near twice as long as broad, and almost twice as broad as thick. Sometimes it is divided into lobules, but for the most part has only one or two small fissures on its edge, and sometimes none; in its colour it resembles cast iron. The inner texture, in brutes, is vesicular, like the penis; in which vesicles are found grumous blood, and small bodies like glands: but Ruysch denies that the human spleen is of the same texture. The spleen I have seen taken out of a dog, without any remarkable inconvenience to him. I have twice, in a human body, seen three spleens, twice two, and once four; some of these were very small, others nearly equal, but altogether in any of these bodies were not larger than the one which is usually found.

CHAPTER VI.

OF THE VASA LACTEA.

VASA lactea are the venæ lacteæ, receptaculum chyli, and ductus thoracicus.

Venæ lacteæ, &c. are a vast number of very fine pellucid tubes, beginning from the small guts, and proceeding thence through the mesentery; they frequently unite, and form fewer and larger vessels, which first pass through the mesenteric glands, and then into the receptaculum chyli. These vessels, ere they arrive at the mesenteric glands, or in dogs the pancreas asellii, which is these glands collected, are called venæ lacteæ primi generis; and thence to their entrance into the receptaculum chyli, venæ lacteæ secundi generis. The office of these veins is to receive the fluid part of the digested aliment, which is called chyle, and convey it to the receptaculum chyli, that it may be thence carried through the ductus thoracicus into the blood vessels.

For the following excellent description, thus marked ", of the receptaculum chyli, and ductus thoracicus, I am obliged to Mr. Monro.

" Receptaculum chyli pecqueti, or saccus lac-
" teus van horne, is a membranous somewhat
" pyriform bag, two thirds of an inch long,
" one third of an inch over in its largest part,
" when collapsed; situated on the first vertebra
" lumbrorum, to the right of the aorta, a little higher

"than the arteria emulgens dextra, under the right
"inferior muscle of the diaphragm. It is formed
"by the union of three tubes; one from under
"the aorta, the second from the interstice of the
"aorta and cava, the third from under the emulgents
"of the right side. The saccus chyliferus at its
"superior part becoming gradually smaller, is con-
"tracted into a slender membranous pipe of about
"a line diameter, well known by the name of

"Ductus thoracicus. This passes betwixt the
"appendices musculosæ diaphragmatis, on the
"right of, and somewhat behind the aorta, then
"lodged in the cellular substance under the pleu-
"ra; it mounts between this artery and vena sine
"pari, or azygos, as far as the fifth vertebra
"thoracis, where it is hid by the azygos, as this
"vein rises forward to join the cava descendens;
"after which the duct passes obliquely over to the
"left side under the œsophagus, aorta, descendens,
"and great curvature of the aorta, until it reaches
"the left carotid, stretching farther towards the
"left internal jugular, by a circular turn, whose
"convex part is uppermost: at the top of this arch
"it splits into two for one half line, the superior
"branch receiving into it a large lymphatic from
"the cervical glands. This lymphatic appears, by
"blowing and injections, to have two valves;
"when the two branches are united, the duct con-
"tinues its course to the internal jugular, behind
"which it descends, and immediately at the left

" side of the insertion of this vein, enters the su-
" perior and posterior part of the left subclavian,
" whose internal membrane duplicated forms a se-
" milunar externally convex valve that covers two
" thirds of the orifice of the duct. Immediately
" below this orifice a cervical vein from the mus-
" culi scaleni enters the subclavian. The thin coat
" and valves, commonly ten or twelve, of this duct,
" are so generally known, I need not mention them.
" In my notes I find little variation in the recep-
" taculum, only its different capacities in different
" subjects, and sometimes more ducts concurring
" in the formation of it. The diameter of the duct
" varies in most bodies, and in the same subject is
" uniform, but frequently sudden enlargements or
" sacculi of it are observable. The divisions which
" authors mention of this duct within the thorax
" are very uncertain. In a woman I dissected last
" summer, at the eighth vertebra thoracis, one
" branch climbed over the aorta, and about the
" fifth vertebra slipped back again under that artery
" to the other branch, which continued in the or-
" dinary course. Last winter I found this duct of
" a man discharging itself entirely into the right
" subclavian vein. The precise vertebra, where it
" begins to turn towards the left, is also uncertain.
" Frequently it does not split at its superior arch;
" in which case a large saccus is found near its aper-
" ture into the subclavian vein. Generally it has
" but one orifice, though I have seen two in one

"body, and three in another; nay, sometimes it "divides into two under the curvature of the great "artery; one goes to the right, another to the left "subclavian; this however is very rare. The lym-"phatic, which enters the superior arch, is often "sent from the thyroid gland."

Supposing there ordinarily passes five pounds of chyle in a day through the lacteals, and that four ounces of this only are added to the blood (though it may be any other quantity, for aught I know) and that a man neither decreases or increases during this time, then all the separations from the fluids and solids must be just five pounds; four ounces of which must be those fluids and particles of solids, which are become unprofitable; and the remaining four pounds twelve ounces will serve as a vehicle to carry the four ounces off: so that we see for what reason more fluids are carried into the blood than are to be retained there, and how the body is by the same means both nourished and preserved in health.

CHAPTER VII.

OF THE PLEURA, MEDIASTINUM, LUNGS, PERICARDIUM, AND HEART.

PLEURA is a fine membrane which lines the whole cavity of the thorax, except on the diaphragm, which is covered with no other than its own proper membrane. The back part of it is extended over the great vessels, like the peritonæum; and in regard this membrane passes partly under these vessels, as the peritonæum does in the abdomen, they may be said to lie in a duplicature of it; it serves to make the inside of the thorax smooth and equal.

Mediastinum divides the thorax lengthways, from the sternum to the pericardium and pleura, which is a very short space, but in many brutes very considerable. It divides into two in men, but in brutes it is single; it divides the thorax not exactly in the middle, but towards the left side, and is so disposed, that the two cavities, into which it divides the thorax, do not end toward this membrane in an angle, but a segment of a circle; it hinders one lobe of the lungs from incommoding the other, as in lying on one side the uppermost might do; and prevents the disorders of one lobe of the lungs from affecting the other.

The lungs are composed of two lobes, one seated on each side of the mediastinum; each of which

lobes are subdivided into two or three lobules, which are most distinctly divided in such animals as have most motion in their backs, for the same end that the liver is in the same animals. They are each composed of very small cells, which are the extremities of the aspera arteria or bronchos. The figure of these cells is irregular; yet they are fitted to each other so as to have common sides, and leave no void space. Into these cells the blood vessels discharge a large quantity of lymph, or materia perspirabilis, which at once keeps them from being dried by the air, and makes a large and necessary discharge from the blood, as has already been observed upon the subject of perspiration through the skin. Dr. WILLIS has given a very particular description of the inner texture of the lungs, but it is only imaginary and false, as he, and they who have copied his cuts and descriptions, could not but have known, if they had ever made the least inquiry into the lungs of any animal; nor is his account of the lymphatics on the surface of the lungs, at all more true than that of their texture. In the membranes of these cells are distributed the branches of the pulmonary artery and vein. The known uses of the air's entering the lungs, are to be instrumental in speech, and to convey effluvia into the nose, as it passes for the sense of smelling; but the great use of it, by which life is preserved, I think we do not understand. By some the force of the air is thought to separate the globuli of the blood that

have cohered in the slow circulation through the veins; and this opinion seems to be favoured by the many instances of polypuses, which are large concretions of the globuli of the blood, found in the veins near the heart, and in the right auricle and ventricle of the heart; and their being so seldom found in the pulmonary veins, or in the left auricle or ventricle of the heart, or in any of the arteries; but if it is true that, while the blood passes through the lungs, many cohering globuli are separated, yet it remains to be proved that these separations are made by the force of the air. Dr. KEIL has computed the force of the air in the strongest exspirations against the sides of all the vesicles, to be equal to fifty thousand pound weight; which though we should grant, we shall still find the moment of the air in the lungs exceeding small in any small space. For the velocity with which the air moves in the lungs is as much less than that with which it moves in the windpipe, as the square of a section of the cells in the lungs is greater than the square of a section of the windpipe; and therefore if the square of all the extreme blood vessels in the lungs do not bear a greater proportion to the square of the large pulmonary vessels than the square of the cells do to the windpipe, and if the blood in these large vessels moves as fast as the air in the windpipe, then the blood moving in the smallest vessels of the lungs with a velocity equal to that of the air in the cells, the blood will have as much more attrition from

the power that moves it in its own vessels, than the air can give upon them, as blood is heavier than air. Besides, air pressing equally to all sides, and the globuli of the blood swimming in a fluid; this pressure, be it what it will, I think, can be of little use to make such separations. Indeed it may be objected that the greatest pressure is in exspiration, yet that surely cannot be very great, while the air has so free a passage out of them. Others have thought, that the air enters the blood vessels from the cells in the lungs, and mixes with the blood; but this opinion, however probable, wants sufficient experiments to prove it; air being found in the blood, as it certainly is, is no proof of its entering this way, because it may enter with the chyle: nor is the impossibility which has been urged of its entering at the lungs without the blood being liable to come out the same way into the vesicles of the lungs, a good argument to the contrary; for if a pliable duct passes between the membranes of a vessel, through a space greater than the square of its orifice, no fluid can return, because the pressure which should force it back will be greater against the sides of that duct than its orifice; which is the case of the bile-duct entering the duodenum, and the ureters entering the bladder. I think the most probable argument for the air's entering into the blood by the lungs, or rather some particular part of the air, may be fetched from a known experiment of each man in a diving bell

wanting near a gallon of fresh air in a minute; and if pressure only was wanted in this case, they often descend, till the pressure of the air is three or four times what it is upon the surface of the earth, without any advantage from that pressure; and animals dying so soon in air that has been burnt, and their being so easily intoxicated by breathing air much impregnated with spirituous liquors, are also arguments of a passage this way into the blood. Besides, if pressure of the air in the cells of the lungs is the only use of it, I do not see but enough of that may be had while a man is hanging, if the muscles of the thorax do but act upon the air which was left in the thorax when the rope was first fixed, and yet death is brought about by hanging no other way than by interrupting of the breath, as I have found by certain experiments. Dr. DRAKE has endeavoured to shew, that the use of respiration is to assist the systole of the heart; but this use requires that the systole and diastole of the heart should keep time with exspiration and inspiration, which is contrary to experience. The lungs of animals, before they have been dilated with air, are specifically heavier than water; but upon inflation they become specifically lighter, and swim in water; which experiment may be made to discover whether a dead child was still born, or not; but if the child has breathed but a little, and the experiment is made long after, the lungs may be collapsed and grow heavier than water, as I have experiment-

ed, which may sometimes lead a man to give a wrong judgment in a court of judicature, but then it will be on the charitable side of the question. Adhesions of the lungs to the pleura are in men so common, that I know not how to call it a disease; they being found so more or less in most adult persons, and without any inconvenience, if the lungs are not rotten.

Pericardium, or heart purse, is an exceeding strong membrane which covers the heart; its side next the great vessels is partly connected to them, and partly to the basis of the heart, but, I think, not properly perforated by those vessels; and its lower side is inseparable from the tendinous part of the diaphragm, but not so in brutes, in some of which there is a membranous bag between it and the diaphragm, which contains a lobule of the lungs. It encloses all the heart to its basis; its uses are to keep the heart in its place, without interrupting its office, to keep it from having any friction with the lungs, and to contain a liquor to lubricate the surface of the heart, and abate its friction against the pericardium.

The heart is a muscle of a conic figure, with two cavities or ventricles; its basis is fixed by the vessels going to and from it, upon the fourth and fifth vertebræ of the thorax; its apex, or point, is inclined downward and to the left side, where it is received in a cavity of the left lobe of the lungs, as may be observed, the lungs being extended

with air. This incumbrance on the left lobe of the lungs, I imagine, is the cause of that side's being most subject to those pains which are usually called pleuritic, which I have ever found upon dissecting of them to be inflammations in the lungs.

At the basis of the heart, on each side, are situated the two auricles to receive the blood; the right from the two venæ cavæ, and the left from the pulmonary veins; in the right, at the meeting of the cavæ, is an eminence called tuberculum Loweri, which directs the blood into the auricle; immediately below this tubercle, in the ending of the cava ascendens, is the vestigium of the foramen ovale (vid. chap. Of the fœtus;) and near this, in the auricle, is the mouth of the coronary veins. Both auricles are strengthened by muscular columnæ, like the ventricles. The left is much less than the right; but the difference is supplied by a large muscular cavity, which the veins from the lungs afford in that place. The sides of this muscular cavity are thicker than the sides of the right auricle, in about that proportion, in which the left ventricle of the heart is stronger than the right; their uses being to receive blood from the veins that lead to the heart, and press it into the ventricles, a strength in each auricle proportionable to the strength of the ventricle that it is to fill with blood, seems necessary: and this different thickness of the coats of the auricles makes the blood in the left, which is thickest, appear through it of a paler red; but when it is let

out of the auricles, it appears alike from both; which they would do well to examine, who affirm the blood returns from the lungs of a more florid colour than it went in; and offer it as an argument of the blood's being mixed with air in the lungs. The ventricles or cavities in the heart which receive the blood, are hollow muscles, or two cavities in one muscle, whose fibres intersect one another, so as to make the pressure of the heart upon the blood more equal and effectual, and are also less liable to be separated than they would have been, if they had lain in one direction. Both these cavities receiving the same quantities of blood in the same times, and always acting together, must be equal in size, if they equally discharge what they contain at every systole, as I doubt not but they do; nevertheless, the left appears less than the right, it being found empty in dead bodies, and the right usually full of blood; which made the ancients think the veins and the right ventricle only were for the blood to move in, and that the left and the arteries contained only animal spirits. The left ventricle is much the thickest and strongest, its office being to drive the blood through the whole body, while the right propels it through the lungs only. Over the entrance of the auricles in each ventricle, are placed valves to hinder the return of blood while the heart contracts. Those in the right ventricle are named tricuspides, those in the left mitrales. One of these last seems to do further service, by covering the

mouth of the aorta while the ventricle fills; which suffering none of the blood to pass out of this ventricle into the aorta before the ventricle acts, it will be able to give greater force to the blood than it otherwise might have done; because a greater quantity of blood more fully distending the ventricle, and making the greater resistance, it will be capable of receiving the greater impressed force from the ventricle; and if the blood is no way hindered in the right ventricle from getting into the pulmonary artery, while the ventricle dilates, as it is in the left, the left then may be somewhat bigger than the right, if they both empty themselves alike in every systole. Though the auricles of the heart are equal to each other, and the two ventricles also equal or nearly equal, yet the auricles are not so large as the ventricles; for the ventricles contain not only all the blood which flowed from the veins into the auricles, during the contraction of the heart, but also that which flows (which will be directly into the heart) while the auricles contract, and the ventricles dilate; which leads us to the exact knowledge of the use of the auricles. If the systole and diastole of the heart are performed in equal times, then the auricles must be half the size of the ventricles; or whatever proportion the space of time, of the systole of the heart bears to the space in which the systole and diastole are both performed, that proportion will the cavities of the auricles bear to the cavities of the ventricles. The inner

fibres of each ventricle are disposed into small cords, which are called columnæ : from some of these stand small portions of flesh called papillæ ; these papillæ are tied to the valves by slender fibres, whereby they keep the valves from being pressed into the auricles by the action of the blood against them in the systole of the heart : and when that is over, the blood flowing in between them opens them, as the pressure of blood on the other side shuts them in the systole. For the course of the blood through this part, vid. chap. Of the course of the aliment and fluids. In the beginning of each artery from the heart are placed three valves, which look forward, and close together to hinder a regress of blood into the ventricles. Those in the pulmonary artery are named sigmoidales, those in the aorta, semilunares. For the canalis arteriosus, vid. chap. Of the fœtus.

In a boy I found a great quantity of pus in the pericardium, and the basis of the heart ulcerated. In persons that have died of a dropsy, I have usually observed the heart large, its fibres lax, and the vessels about it immoderately distended, and polypuses sometimes in both auricles and ventricles, and in the large veins ; but more frequently in the right auricle and ventricle. Mr. Pile has prepared a heart thus diseased, whose circumference from the vertex round the base of the auricles measures twenty four inches and a quarter, and round the base of the ventricles seventeen

inches and a half. I dissected a man that died tabid, in whom the pericardium universally adhered to the heart, and a portion of the muscular part of the heart was ossified as large as a sixpence. The beginning of the aorta is frequently seen ossified, especially in aged persons. In a woman that died of a dropsy, I found the valves of the aorta quite covered with chalk stones, which not suffering the valves to do their office, the left ventricle of the heart was constantly overcharged with blood, and distended to above twice its natural bigness, which, I imagine, destroyed the economy of the body, and occasioned the dropsy.

Upon opening the body of a person, who died with excessive palpitations of the heart and uneven pulse, which began after very hard drinking, in extreme hot weather, some years before, I found about ten inches of the aorta nearest the heart distended three times its natural diameter; and in a man one hundred and three years old, I found the same part of the aorta extended twice its natural capacity, without any symptom of such a disorder when living.

CHAPTER VIII.

OF THE ARTERIES AND VEINS.

FROM the right ventricle of the heart arises the pulmonary artery, which soon divides into two branches, one to each lobe of the lungs; then they subdivide into smaller and smaller branches, until they are distributed through every part of the lungs. From the extreme branches of the pulmonary artery arise the small branches of the pulmonary veins; which, as they approach the left auricle of the heart, unite in such a manner as the pulmonary artery divides going from the heart, only that the veins enter the muscular appendix of the left auricle in several branches, and the blood being brought back from the lungs by these vessels to the left auricle and ventricle of the heart, it is from the left ventricle of the heart thrown into the aorta.

Aorta, or great artery, arises from the left ventricle of the heart, and deals out branches to every part of the body. The first part of this vessel is called aorta ascendens: it passes over the left pulmonary artery, and veins, and branch of the aspera arteria, and being reflected under the left lobe of the lungs, it commences aorta descendens; which name it keeps through the thorax and abdomen, where it passes on the left side of the spine, till its

division into iliac arteries between the third and fourth vertebræ of the loins.

From under two of the semilunar valves of the aorta, which is ere it leaves the heart, arise two branches (sometimes but one) which are bestowed upon the heart, and are called coronariæ cordis. From the curved part of the aorta, which is about two or three inches above the heart, arise the subclavian and carotid arteries; the right subclavian and carotid in one trunk, but the left single. By some authors these vessels have been described in a different manner; but I believe their descriptions were, for want of human bodies, taken from brutes; for I have never yet seen any variety in these vessels in human bodies, though I have in the veins nearer the heart: and indeed there seems to me to be a mechanical reason for their going off in the manner here described, in human bodies; for the right subclavian and carotid arteries necessarily going off from the aorta at a much larger angle than the left, the blood would move more freely into the left than the right, if the right did not go off in one trunk, which gives less friction to the blood than two branches equal in capacity to that one; so that the advantage the left have by going off from the aorta at much acuter angles than the right, is made up to the right by their going off at first in but one branch.

The carotid arteries run on both sides the larynx to the sixth foramina of the scull, through

which they enter to the brain; but as they pass through the neck, they detach branches to every part about them, which branches are called by the names of the parts they are bestowed upon; as, laryngeæ, thyroideæ, pharyngeæ, linguales, temporales, occipitales, faciales, &c. but just before they enter the sixth foramina of the scull, they each send a small branch through the fifth foramina to that part of the dura mater which contains the cerebrum. It is these arteries which make those impressions which are constantly observed on the inside of the ossa bregmatis: these branches, Mr. MONRO observes, oftener arise from the temporal arteries. The internal carotids send two branches to the back part of the nose, and several branches through the first and second foramina of the scull to the face and parts contained within the orbits of the eyes, and then piercing the dura mater, they each divide into two branches, one of which they send under the falx of the dura mater, between the two hemispheres of the brain, and the other between the anterior and posterior lobes. These branches take a great many turns, and divide into very small branches in the pia mater before they enter the brain, as if the pulse of larger arteries would make too violent an impression on so tender and delicate a part. And perhaps it may be from an increase of the impulse of the arteries in the brain, which strong liquors produce, that the nerves are so much interrupted in their uses throughout the

whole body, when a man is intoxicated with drinking; and may it not also be from a like cause that men are delirious in fevers? Besides these two arteries, viz. the carotids, the brain has two more, called cervicales, which arise from the subclavian arteries, and ascend to the head through the foramina, in the transverse processes of the cervical vertebræ, and into the scull through the tenth or great foramen. These two arteries uniting soon after their entrance, they give off branches to the cerebellum, and then passing forward, divide and communicate with the carotids; and the carotid arteries communicating with each other, there is an entire communication between them all; and these communicant branches are so large that every one of these four great vessels, with all their branches, may be easily filled with wax through any one of them.

The subclavian arteries are each continued to the cubit in one trunk, which is called axillaris as it passes the arm pits, and humeralis as it passes by the inside of the os humeri, between the muscles that bend and extend the cubit. From the subclavians within the breast arise the arteriæ mammariæ, which run on the inside of the sternum, and lower than the cartilago ensiformis. Soon after the arteria humeralis has passed the joint of the cubit, it divides into two branches, called cubitalis superior, and cubitalis inferior; which latter soon sends off a branch, called cubitalis media, which is bestowed

upon the muscles seated about the cubit. The cubitalis superior passes near the radius, and round the root of the thumb, and gives one branch to the back of the hand, and two to the thumb ; one to the first finger and a branch to communicate with the cubitalis inferior. The cubitalis inferior passes near the ulna to the palm of the hand, where it takes a turn, and sends one branch to the outside of the little finger, another between that and the next finger, dividing to both, another in the same manner to the two middle fingers, and another to the two fore fingers. These branches which are bestowed on the fingers run one on each side of each finger internally to the top, where they have small communications, and very often there is a branch of communication between the humeral and inferior cubital arteries. This communicant branch is sometimes very large, and liable to be pricked by careless or injudicious blood letters, in bleeding in the basilic vein, immediately under which, as far as I have been able to observe, this branch always lies. Mr. MONRO has found the subclavian artery divided, in one subject, into two, the exterior of which formed the cubitalis superior, and the inner artery, the cubitalis inferior ; from which structure he accounts for the success in the operation of the aneurism sometimes performed above the cubit. When the operation for an aneurism is made upon this communicant branch, it is found necessary to tie it on both sides of the

orifice, because the blood is liable to flow freely into it either way.

From the descending aorta on each side is sent a branch under every rib, called intercostalis, and about the fourth vertebra of the back it sends off two branches to the lungs, called bronchiales, which are sometimes both given off from the aorta, sometimes one of them from the intercostal of the fourth rib on the right side; and as the aorta passes under the diaphragm, it sends two branches into the diaphragm, called arteriæ phrenicæ, which sometimes rise in one trunk from the aorta, and sometimes from the cœliaca; but oftener the right from the aorta, and the left from the cœliaca. Immediately below the diaphragm arises the cœliac artery from the aorta; it soon divides into several branches, which are bestowed upon the liver, pancreas, spleen, stomach omentum, and duodenum. These branches are named from the parts they are bestowed on, except two that are bestowed upon the stomach, which are called coronaria superior and inferior, and the branch bestowed upon the duodenum, which is named intestinalis. At a very small distance below the arteria cœliaca from the aorta arises the mesenterica superior, whose branches are bestowed upon all the intestinum jejunum and ilium, part of the colon, and sometimes one branch upon the liver. A little lower than the superior mesenteric artery arise the emulgents, which are the arteries of the kidneys. And a little lower than the emulgents, for-

ward from the aorta, arise the arteriæ spermaticæ; for which, vid. chap. Of the parts of generation in men. Lower laterally the aorta sends branches to the loins, called lumbales; and one forward, to the lower part of the colon and the rectum, called mesenterica inferior. Between the arteria cœliaca, mesenterica superior and inferior, and the branches of each near the guts, there are large communicant branches to convey the blood from one to another, when they are either compressed by excrements, or from any other cause.

As soon as the aorta divides upon the loins, it sends off an artery into the pelvis upon the os sacrum, called arteria sacra, and the branches the aorta divides into are called iliacæ, which in about two inches space divide into external and internal. The iliacæ internæ first send off the umbilical arteries, which are dried up in adult bodies, except at their beginnings, which are kept open for the collateral branches on each side, one to the bladder, and one to the penis in men, and in women the uterus: the rest of these branches are bestowed upon the buttocks and upper parts of the thighs. The iliacæ externæ run over the ossa pubis into the thighs; and as they pass out of the abdomen they send off branches, called epigastricæ to the fore part of the integuments of the abdomen under the recti muscles. And the epigastric arteries send each a branch into the pelvis, and through the foramina of the ossa innominata to the muscles

thereabouts. As soon as the iliac artery is passed out of the abdomen into the groin it is called inguinalis, and in the thigh cruralis, where it sends a large branch to the back part of the thigh ; but the great trunk is continued internally between the flexors and extensors of the thigh, and passing through the insertion of the triceps muscle into the ham, it is there called poplitea ; then below the joint it divides into two branches, one of which is called tibialis antica ; it passes between the tibia and fibula to the fore part of the leg, and is bestowed upon the great toe, and one branch to the next toe to the great one, and another between these toes, to communicate with the tibialis postica ; which artery, soon after it is divided from the antica, sends off the tibialis media, which is bestowed upon the muscles of the leg ; the tibialis postica goes to the bottom of the foot and all the lesser toes. The tibialis antica is disposed like the cubitalis superior ; the postica like the cubitalis inferior ; and the mediæ in each have also like uses. These arteries which I have described, are uniform in most bodies, but the lesser branches are distributed like the branches of trees, in so different a manner in one body from another, that it is highly probable no two bodies are exactly alike, nor the two sides in any one body.

I have once seen a rupture of matter, and once of blood and matter, which flowed out of the abdomen into the fore part of the thigh, through the

same passage at which the iliac artery goes out of the abdomen.

The veins arise from the extremities of the arteries, and make up trunks which accompany the arteries in almost every part of the body, and have the same names in the several places which the arteries have, which they accompany. The veins of the brain unload themselves into the sinuses (vid. chap. Of the dura and pia mater) and the sinuses into the internal jugulars and cervicals; and the internal jugulars and cervicals into the subclavians, which joining, make the cava descendens. The internal jugulars are seated by the carotid arteries, and receive the blood from all the parts which the carotids serve, except the hairy scalp and part of the neck, whose veins enter into the external jugulars, which run immediately under the musculus quadratus genæ, often two on each side. The cervical veins descend two through the foramina in the transverse processes of the cervical vertebræ, and two through the great foramen of the spine, and one on each side the spinal marrow; these join at the lowest vertebra of the neck, and then empty into the subclavians, and at the interstices of all the vertebræ communicate with one another.

The veins of the limbs are more than double the number of the arteries, there being one on each side of each artery, even to the smallest branches that we can trace, besides the veins which lie immediately under the skin. Those which accompany the

arteries, have the same names with the arteries; those which run immediately under the skin on the back of the hand, have no proper names; they run from thence to the bend of the elbow, where the uppermost is called cephalica, the next mediana, the next basilica. These all communicate near the joint of the elbow, and then send one branch which is more directly from the cephalica, and bears that name until it enters the subclavian vein; it passes immediately under the skin, in most bodies, between the flexors and extensors of the cubit, on the upper side of the arm. The other branches joining, and receiving those which accompany the arteries of the cubit, they pass with them by the artery of the arm into the subclavian vein. The external veins have frequent communications with the internal, and are always fullest when we use the most exercise; because the blood being expanded by the heat which exercise produces, it requires the vessels to be distended; and the inner vessels being compressed by the actions of the muscles, they cannot dilate enough; but these vessels being seated on the outsides of the muscles, are capable of being much dilated; and this seems to me to be the chief use of these external vessels. The cephalic vein, as it runs up the arm, is very visible in most men, but in children is rarely to be seen; therefore great care should be taken not to wound it in the cutting of issues in children's arms; and I know no way to be sure of avoiding it, but by cutting the

issue more externally than is usual in men, which may be done without any inconvenience.

In the thorax, besides the two cavæ, there is a vein called azygos, or vena sine pari; it is made up of the intercostal, phrenic, and bronchial veins, and enters the descending cava near the auricle, as if its use was to divert the descending blood from falling too directly upon the blood in the ascending cava, and direct the blood of the descending cava into the auricle.

In the abdomen (besides the cava ascendens and the veins which are named like the arteries, viz. the emulgents from the kidneys, the lumbal and spermatic veins, the sacra, iliac, and hypogastric veins) there is one large one called vena portæ, whose branches arise from all the branches of the cœliac and two mesenteric arteries, except those branches of the cœliac and superior mesenteric, which are bestowed on the liver, and uniting in one trunk enters the liver, and is there again distributed like an artery, and has its blood collected and brought into the cava by the branches of the cava in the liver; this vein being made use of instead of an artery to carry blood to the liver, for the separation of bile. It moves here about eight times slower than in the arteries hereabouts; and this slow circulation being supposed necessary, I think, there seems no other way so fit to procure it; for if an artery had been employed for this use, and been thus much dilated in so short a passage,

the blood would not have moved so uniformly in it, but faster through its axis than near its sides; and besides, it is very probable that the blood in this vein, having been first employed in nourishing several parts, and having through a long space moved slowly, may be made thereby fitter for the separation of bile, than blood carried by an artery dilated to procure a circulation of the same velocity with that in this vein.

In the leg the veins accompany the arteries in the same manner as in the arm, the external veins of the foot being on the upper side, and from them is derived one called saphena, which is continued on the inside of the limb its whole length, and has several names given it from the several places through which it passes.

The arteries have three coats; a middle muscular, and an external and internal membranous. The veins are said to have the same; the internal coat of an artery may be pretty easily separated, but not the external; and though the veins have muscular fibres, yet I could never separate any one distinctly into three coats; and in the inside of the veins there are many valves, especially in the lower limbs, to hinder any reflux of the venal blood, which otherwise would have happened from the frequent actions of the muscles on the outsides of the veins; and both the arteries and veins, as they run in the inside of the limb, or as they are dispersed in parts that suffer great extensions, as the

stomach, guts, and uterus, they are curved so much as that when these parts come to be distended, they may comply with those distensions by only being straitened, and so preserved from being stretched, which would lessen their diameters. The small arteries near the heart go off from the large trunks at obtuse angles, farther at less obtuse angles, then at right angles, farther still at acute angles, and near the extremities at very acute angles, because the blood in the vessels far from the heart moving with less velocity than the blood in the vessels near the heart, the blood in the collateral branches more remote from the heart wants the advantage of a directer course; and because a very large branch arising out of another, might weaken too much the sides of the vessel it would arise from, that inconvenience is prevented by increasing the number, and so lessening the size of the collateral branches, where otherwise one large branch would have served better; as in the going off of the subclavian and carotid arteries, which might have gone off for some space in one trunk; but this mechanism is more evident in the going off of the arteria cœliaca and mesenterica superior. And the small arteries always divide so as that the lesser branch may lie least in the direction of the blood flowing into them, which makes the blood flow most freely into that branch that hath farthest to carry it; and the smaller branches arise more or less obliquely from the sides of other arteries, according to the

proportion they bear to the arteries they arise from, because an artery comparatively large arising obliquely from the side of another, would make an orifice in that it arises from too large, and weaken it. And both these ends are at once brought about, by making the arteries, that give off the branches, bend more or less toward the branches they give off, according to the comparative magnitude of the branches given off.

Borelli has computed the force which the heart exerts at every systole, to be equal to three thousand pounds weight, and the force which all the arteries exert at every systole, to be equal to sixteen thousand pounds weight, and that they together overcome a force equal to an hundred and thirty six thousand pounds weight; and Dr. Keil has computed that the heart in every systole exerts a force not exceeding eight ounces. The first computation was made by comparing the heart with other muscles, whose power to sustain a weight could be best determined; and the latter was made from the velocity of the blood moving in an artery: therefore if we consider that Borelli's way of computing led him to find out the absolute force of the heart, and Dr. Kiel's the force which the heart usually exerts, perhaps these very different computations may be accounted for; for if the force of the heart, which is constantly exerted, should, compared with any other muscle, be but in a reciprocal proportion to the frequency of their actions, and

the importance of their uses; may not the heart very fitly have a force vastly greater than usually it exerts, because it is always in action, and must be able to exert a certain force in the lowest state of health? What force the heart ever exerts in a grown man, I cannot say; but it must be less in each ventricle than is sufficient to burst the valves, which hinder the blood from returning into the auricles out of the ventricles, or than is sufficient to break those threads by which these valves are tied to the papillæ. In a dog, I found the force which the heart would exert, would not raise to one foot perpendicular height a column of blood through the aorta ascendens. And when I inject the arteries of a child, I find a force exceeding little will throw water through all the vessels, with a velocity equal to that with which the blood moves in those vessels when living. And if the heart, like other muscles, can perform the first part of its contraction with most ease, are not the quick actions of the heart in hectic fevers owing to its not being able to empty the ventricles every systole, which, I think, will oblige it to act, cæteris paribus, so much the oftener? For the following ingenious attempt to account for the systole and diastole of the heart, and the reciprocal actions of the auricles and ventricles, I am obliged to Mr. MONRO.

"Postulata, that the action of the muscles de-"pends on the influx of blood and liquidum ner-"vosum into the muscular fibres, and therefore,

" whenever the muscles are deprived of either or " both these fluids, their action ceases; this a great " many authors have fully proved by tying and " cutting the nerves and arteries that serve any " muscle. That all muscles are in a constant state " of contraction as long as the blood and liquidum " nervosum are freely supplied to them, which " seems evident from the sphincter ani and vesicæ, " and from the continued contraction of such mus- " cles, whose antagonists are cut asunder, or pa- " ralytic. That the nerves of the heart run to it " between the auricles and arteries, and that the " arteriæ coronariæ rise from the aorta behind the " valvulæ semilunares, both which are evident from " dissections. If then both auricles and ventricles " are ready, upon the first communication of mo- " tion, to contract at the same time, the ventricles, " as Dr. KEIL well observes, being stronger, will " first contract, and hinder the contraction of the " auricles, which must be in the mean time much " dilated by the influx of blood from the veins, " while the arteries are also distended by the blood " thrown out of the ventricles; therefore the car- " diac nerves lying between the two will be com- " pressed, and the course of the liquids in them stop- " ped; at the same time the blood that rushes out " of the left ventricle into the aorta, pushes the " valves of that artery upon the orifices of the ar- " teriæ coronariæ, so that no blood can enter into " the substance of the heart; thus both causes of

"contraction failing, this muscle must become pa-
"ralytic. The resistance then to the contraction of
"the auricles being now removed, they will throw
"their blood into the ventricles; and the impulsion
"of blood into the arteries from the heart now also
"ceasing, the two great arteries will be constrict-
"ed: the nerves are therefore now again free from
"compression, and the valves of the aorta being
"thrust back upon the mouth of the ventricle, the
"blood enters the arteriæ coronariæ; since the ven-
"tricles are again supplied with both the liquids
"on which their contraction depends, they must
"again act. And thus as long as these causes con-
"tinue, their effects must follow, i. e. as long as
"the creature lives, the heart must have an al-
"ternate systole and diastole, and the auricles and
"ventricles have reciprocal actions."

If the arteries contract, suppose a fourth part of the squares of their diameters at every systole, and if the heart does not throw out a quantity at every systole, equal to the fourth part of the solid contents of all the arteries when dilated, it is evident the heart does not throw the blood through the whole arterial system, but into so much of the arteries nearest the heart, as will contain four times as much as is thrown out of the left ventricle at once: and then this portion of arteries throws the blood forwards and dilates the arteries that lie next, and so on: but if the capacities of all the arteries taken together in their utmost dilatations, exceed

their capacities in their utmost contractions, just so much as the quantity of blood amounts to, which is thrown out of the left ventricle of the heart at every systole, which I believe is the case, then every contraction of the heart propels the blood through the whole arterial system, which may be the reason why the largest animals, cæteris paribus, have the slowest pulses and least vigour in their motions, and perhaps too for the same reason require a less proportion of food. The sections of all the remoter vessels being greater than a section of the aorta, the blood will move so much slower in the lesser vessels than in the greater, as the sections of the lesser vessels taken together exceed the section of the greater vessel or vessels. The strength of the coats of the arteries, if the blood pressed equally against the sides of them all, cæteris paribus, ought to be one to another as their circumferences, because so much as the circumference of one artery is greater than another, so much greater pressure its sides must sustain; but the arteries nearest the heart, sustaining the reaction of all the arterial blood, they must have a strength yet greater than in that proportion; and the vessels, both arteries and veins, the more distant they are from the head, the greater proportional strength their coats must have, because the arterial and venal blood communicating, they will press upon the lower vessels, with a force proportional to the perpendicular altitude of blood above, which will be that of

the perpendicular altitude of the whole body; for though the ascending blood of the arteries may be said not to press upon the descending, because it moves another way, nevertheless, it being thrown from the heart into one common vessel, which afterwards divides, the blood moving both ways communicates, and that force which is necessary to overcome the natural inclination of the ascending blood to descend, will be impressed also upon the descending blood, which is just the same with the weight of the ascending blood; and the veins both from above and below communicating at the right auricle, the pressure in them will also be as the perpendicular altitude of the body. So that the blood in all the veins and arteries may be compared to a fluid in a curved tube, in which that part in one leg exactly balances that in the other, and both pressing most upon those parts which are nearest the centre of the earth. Accordingly we find by experience, that humours are most apt to flow to the lowest parts, and that by laying those parts upon a level with the whole body, this inconvenience is remedied; but laying a leg only on a chair does it but in part, just so much as the perpendicular altitude of the body from that part is shortened. There is also to be considered concerning the thickness of the coats of the vessels, that the blood moving slower in the small vessels than in the great, the moment of the blood against the sides of a small vessel will be as much less than the moment of the blood

against equal parts of a great one, as the velocity of the blood in a small vessel is less than that in a great one; and therefore their coats may also differ from the former proportion, as the velocity of the blood differs. Most of the small vessels in the limbs lying against one another are a mutual support, and therefore less liable to be dilated or burst than capillaries which lie in the thin membranes of cavities, such as in the nose. Hence these, I suppose, are most subject to hæmorrhages. And if hæmorrhages of blood do frequently arise from obstructions in the minutest vessels, does it not appear how opium and the bark, if they thin the blood inwardly taken (as they do most powerfully when mixed with it) come to be so often effectual remedies in that case? And the coats of the lesser vessels being proportionably weaker than the great ones, according to the decrease of the velocity of the blood, which lessens the moment with which it moves in them, whenever the blood begins to move in them with an equal velocity, or greater, as it happens after an amputation, when the larger vessels are tied, the force of the blood sometimes overcomes the strength of the coats of the smaller vessels, and dilates them so that those vessels which scarce bled during the operation, will sometimes bleed afterwards. And this constant effort of the blood to dilate vessels upon the obstructions of others may cause those throbbing pains which are felt in wounds when the bleeding is stopped, and in all

violent inflammations, until the collateral branches are dilated, or the tension of the parts otherwise taken off.

The extreme branches both of the arteries and veins have very numerous communications, like those in the stamina of the leaves of plants, by which communications the blood that is obstructed in any vessels may pass off by other vessels that are not obstructed ; and the moment of the blood in the vessels lessening, and the friction from the vessels increasing as it approaches the extremities ; and as many of the lesser vessels are more exposed to pressure than any of the large ones, those communications in the lesser vessels are therefore made more numerous. By means of these communications, the blood circulates in a limb that has had part amputated, and into any vessels that have been separated from the trunks that supplied them, which otherwise must have mortified for want of nourishment, and with them, for the same reason, all the branches that arise from such separated vessels ; and I can discern no other way than by these communications, that the fluids contained in a large inflammation can suppurate into one cavity.

If we inject by the arteries a large quantity of a coloured fluid, we find all the large veins full of that liquor before any of the solid parts are much coloured with it ; and upon frequent repetitions all of them much less coloured than, I think, might be

expected, if it had gone into all the vessels of the body; and I have often thrown wax or tallow, coloured with vermilion or verdigrise, through all the arteries, and back again through the veins, even to the heart, every where filling vessels that cannot be discerned without a microscope; and all this without filling or much discolouring any one entire part. In viewing with a microscope the circultion of the blood in the tail of a fish, the eye easily traces arteries to their extremities, and their return in veins; yet all the vessels we can see make but a small part of the whole of what we see; though we are taught that the whole animal body is a compages of vessels, such as we see: but if it were so, I think, we could not well distinguish any; and if the sum of the diameters of all the vessels we can see, are to that of the breadths and thicknesses of all the rest of the parts, which we see at the same time, taken together, but as one to five, these vessels then are no more than the twenty fifth part of what we see with them. What then shall we suppose the rest of the tail, and those parts which were so little tinged, and those which were not filled with wax, in the foregoing experiments, composed of? Are they not composed of vessels which arise from the arteries, as excretory ducts do in a gland, but terminate in the veins? And these vessels being only to convey the nutritious juices, and what else may be a proper vehicle for them, is it not fit the circulation in them should be ex-

ceeding slow, that the nutritious particles may adhere the easier to the fibres of the vessels, which they are to augment or repair? Besides, if any whole part was made up of blood vessels, or any other vessels with fluids moving swiftly in them, it seems to me impossible, that one part of a limb can be very cold while another part is hot, if the warmth of the parts is owing to the fluids they contain. And if there are such vessels as these, the velocity of the motion of their fluids will not depend upon any proportion they bear to the vessels they arise from, but upon the velocity with which their fluids are separated from the arteries into them, and the proportion of the sections of all their orifices to the sum of their own sections, at any distance where we would compare the velocity of their fluids. And the strength of the coats of these vessels may not only be as much less than the strength of the coats of on artery, as their diameters are less, but also less in that proportion in which the velocity of their fluids is less, and the motions more uniform, than the velocity and motion of the blood in an artery.

The coats of the veins are much thinner than those of the arteries, comparing vessels whose sections are equal, because the blood moving slower in the veins than in the arteries, it presses with less moment against their sides: and besides, the blood in the veins has nearly an equal uniform motion, but in the arteries a very unequal one; and that

will require a farther difference in the strength of their coats; for those of the arteries must be equal to the greatest natural pressure; and if the arterial blood propels the venal, that is a farther reason for the different strength of their coats.

All these things being considered, it appears to be a difficult thing to determine nearly, what proportion the fluids of an animal body bear to the solids, or what proportion the sum of all the minutest arteries bear to the aorta, without which, I think, we can neither determine the comparative velocity of the blood moving in the different vessels, nor the quantity of blood in any animal body, nor the time in which the whole mass of blood, or a quantity equal to the whole mass, is flowing through the heart. But if each ventricle of the heart holds five ounces of blood, and they are filled and emptied every systole and diastole, which, I think, is true, and if eighty pulses in a minute be allowed to be a common number, there then flows twenty-five pounds of blood through each ventricle of the heart in a minute. Dr. Keil has shewn that the sum of all the fluids in a man, exceed the sum of all the solids, and yet the quantity of blood which all the visible arteries of a man will contain, is less than four pounds; and if we may suppose all the visible veins, including the vena portæ, hold four times as much, the whole then that the visible vessels can contain is not twenty pounds; but the whole that they do contain is but very little more than the

veins can contain, seeing the arteries are always found almost empty in dead bodies; but how much the invisible arteries and veins contain, I mean those which contain such a compound fluid as is found in the larger vessels, I know no way to judge, unless we knew what proportion these vessels bear to those that carry the nutritious juices and serum (if there are such) without the globuli of the blood. Cæteris paribus, is not the velocity of the blood in all animals proportionable to their quantity of action; and their necessity of food also in proportion to their quantity of action? If so, it appears how those animals which use no exercise, and whose blood moves extremely slow in the winter, can subsist without any fresh supply of food; while others that use a little more exercise, require a little more food; and those who use equal exercise winter and summer, require equal quantities of food at all times; the end of eating and drinking being to repair what exercise and the motion of the blood has destroyed or made useless; and is not the less velocity of the blood in some animals than in others, the reason why wounds and bruises in those animals do not so soon destroy life, as they do in animals whose blood moves swifter?

I had a patient whose muscles on the inside of the thigh were torn to pieces with the cramp, from whence was a vast effusion of blood among the muscles. The tumour being opened, it was judged necessary to take off the limb. The pa-

tient, having a great discharge from the wound, was easy for about ten days; but the cramp then returned into the stump with such excessive torment that he died soon after. I have never heard but of one other case of this kind, which ended in the same manner.

When any of the vessels are lacerated by bruises, strains, or otherwise, without any external wound, purging (which is of more use than one can well account for) and cooling applications are always proper to prevent as much as may be extravasations of blood or serum; but the lacerations once healed, which may be in eight or ten days, and the pain quite gone, then warm medicines may be applied, with opium, or sp. cornu cervi (which powerfully separate coagulated fluids) to help to attenuate and thereby dissipate the extravasated juices.

When the blood vessels become unable to preserve the circulation in the extreme parts, whether from particular weakness in the vessels, or any other decay, I have always observed it to be hurtful to scarify. It lets out the juices that should assist nature to make a separation of the mortified part; nor can it be known in what place we may safely amputate till such a separation which teaches us where it can be supported, and in any place short of that, an operation will be both useless and mischievous. I have known many succeed well who have been thus left to separate, but very few that were otherwise treated; nay, have known some

extraordinary instances of success where the patient had the happiness to have no one about them to interrupt the kind assistance of nature.

CHAPTER X.

OF THE LYMPHÆDUCTS.

LYMPHÆDUCTS are small pellucid cylindrical tubes, which arise invisible from the extremities of the arteries throughout the whole body, but more plentifully in glands than other parts, and in greatest number from such glands as separate the most viscid fluids, as may be observed in the liver and testes. They cannot be discerned in a natural state to have more than one coat, and that exceeding thin, having valves at small and uncertain distances, to prevent the regress of their fluid. They have frequent communications like the veins, but do not unite so often; the larger trunks are in many places attended with small glands, through which they run, and at the same time send communicant branches over them, that they might be secured against obstructions from diseases in those glands. They all terminate in the vasa lactea, or in the large veins. All that rise in the abdomen empty into the venæ lacteæ secundi generis and receptaculum chyli; those in the cavity of the thorax into the ductus thoracicus and the subclavian veins. Their uses are

to carry lymph to dilute the chyle, to make it incorporate more readily with the blood (but not to make it flow the better in the lacteals, as appears sufficiently from their not entering into the minutest lacteals) and to carry off so much lymph as is necessary to leave the blood in fit temper to flow through the veins ; for it is always observed that in such persons as have their blood too thin, the globuli cohere and form moleculæ, or polypuses, which I imagine may arise from the globuli of the blood not rubbing often enough, and with sufficient force one against another to disunite them as fast as they cohere. These polypuses are frequently found in all the large veins, and in the right auricle and ventricle of the heart, especially in such bodies as die hydropic or of any chronic diseases.

Authors have described and painted these vessels as they appear when injected with mercury ; in which case the coat of these vessels being exceeding thin, it is not able any where between the valves to resist the mercury's attracting itself into globules : and the same appearance also happens when they are vastly distended ; because the valves hindering a distention where they are seated, the spaces between them approach to a spherical figure from the equal pressure of the fluid, according to the degree of their distention : but in a natural state, when they are filled with lymph, or when they are moderately injected with air or water, they appear as cylindrical as the veins. Any of these vessels being

burst, they cause a dropsy in the cavity into which they open, which is oftener in the abdomen than the thorax. This kind of dropsy is sometimes cured by tapping, and I believe the reason why it no oftener succeeds is, that it generally takes its rise from a diseased liver. Formerly in this operation only part of the water was drawn off at a time, and the tap sometimes left in the wound to draw off more, which was exceeding painful, and sometimes brought on a mortification ; and if they drew off much water at one time the patient was in great pain, and generally fainted, which was thought to proceed from the loss of too much of the liquor at once. But Dr. Mead, observing that these symptoms could not proceed from the loss of an extravasated fluid, soon found the true cause, which was the sudden want of the pressure of the abdominal muscles against the parts contained in the abdomen ; and in the year 1705, being then physician to St. Thomas's hospital, ordered it to be tried there in the following manner : he directed the abdomen to be pressed by the hands of assistants while the water was running out, and afterwards kept rolled till the muscles recovered force to do their office, and so took out all the water at once, without any inconvenience, which has made this operation not very painful, sometimes successful, and never dangerous. I preserved one woman, by sixteen operations, from the fifty sixth year of her age to eighty ; another six years by sixty six tappings : it

must be confessed, that few cases succeed like these, and very few recover.

I opened a woman, who died of a dropsy in the liver, in which I found the gibbous part entirely wasted, and the coat of the liver about a quarter of an inch thick, which contained about five gallons of a gross yellowish fluid, in which were many hydatids about the size of gooseberries, and some pieces of matter of as bright a red as vermilion. At about fourteen years of age she first began to feel pain in this part, which returned monthly, but in time grew continual, her belly constantly increasing till she died, which was in the twenty eighth year of her age, without ever having had her menses. All the other viscera both in the thorax and abdomen were perfectly sound, nor was there the least sign of the dropsy in any of the limbs, or yellowness in the skin, which is frequent in diseases of the liver,

CHAPTER XI.

OF THE LYMPHATIC GLANDS.

THE glands accompanying the lymphatics are situated in the three cavities, in the interstices of the muscles, where the lymphatics lie with the large blood vessels, and in the four emunctories, viz, the arm pits and groins. In the brain

is seated the glandula pinealis, which I judge to be of this sort, having often seen large lymphæducts running into it from the plexus choroides; and at the basis of the brain in the cella turcica is the glandula pituitaria, into which enters a large lymphatic, as I imagine, named infundibulum (vid. chap. Of the brain.) In the neck are situated a great many of these, by the sides of the carotid arteries and internal jugular veins, and two, or a sort of double one, upon the larynx, immediately below the thyroid cartilage, from which situation they derive the name of thyroideæ; and just within the thorax is seated another, called thymus. In very young children the thymus is as large, or larger, than the thyroic glands; but in men these glands are very large, and the thymus very small, the former having increased in about a double proportion of any other gland of this kind, and the latter having rather diminished than increased; but in brutes, such as have fallen under my observation, it is just the contrary. From which observations I am inclined to conclude, that they both belong to the very same lymphatics, and that either of them increasing as much as both ought to do if both increased, answers the same end as if both did; and that the reason why the thymus increases rather than the thyroid glands in brutes, is because the shape of their thorax affords convenient room for it to lodge in; and that in men the thyroid glands increase so much, because there is no room in that part of

the thorax where the thymus is seated for a large gland to be lodged. In dogs, a porpoise, and some other animals, I have seen the lymphatics in the thymus, and between the thymus and ductus thoracicus, full of chyle, and so in many other lymphatics near the vasa lactea. Under the basis of the heart, and at the sides of the lungs, where the great vessels enter, are many of these glands, from the size of a pea to that of a hazel nut. In the abdomen, upon the loins, near the kidneys, and by the sides of the iliac vessels, are many of these glands, which are called lumbales; and there are some at the hollow side of the liver named hepaticæ: the mesentery also is full of glands of a like appearance; but these seem to belong only to the lacteal veins, unless some of them, which are seated at the basis of the mesentery, among the venæ lacteæ secundi generis, belong to the lymphatics that come from the liver, where the hepatic lymphatics pass in their way to the receptaculum chyli. The glands which accompany the blood vessels in the limbs are few, and distributed in no certain order; except those in the four emunctories, i. e. in the arm pits and groins, named axillares and inguinales.

Brutes have one large one in the thigh, commonly called the pope's eye; this is seated about the great vessels in the thigh, where they pass through the triceps muscle. From this situation, and not from any thing extraordinary in this gland, it is that wounds are there so dangerous.

The lymphatic glands are said by NUCK, and others after him, to be composed of vesicles, and not of vessels like other glands; and that these vesicles are repositories of lymph: but from their appearance in a natural state, which is very compact and uniform, there seems to me to be but little reason for such a conjecture. Some have thought their use to be by contracting to accelerate the motion of the fluid in the lymphatics; but that does not seem very probable, because a muscular coat would have been the readiest means to produce that effect; besides, those vessels seldom enter any of them without detaching a branch over at the same time, perhaps to prevent obstructions. And if these glands were endued with a contracting power, which is only presumed without any proof, it would still be difficult to conceive how such a power, applied at uncertain spaces, should not rather obstruct than accelerate the motion of lymph in the lymphatics, unless there were valves to prevent a reflux; and even then, if this were a convenient piece of mechanism, it would be strange it should no where else in the body be made use of.

These lymphatic glands being diseased, are apt to obstruct and occasion the bursting of the lymphatics that pass through them; which, if in the breast, causes an incurable hydrops pectoris; if in the abdomen, the true ascites, attended with a wasting of the limbs, which is never cured, but may be relieved by tapping.

CHAPTER XII.

OF THE COURSE OF THE ALIMENT AND FLUIDS, ABSTRACTED FROM THE FOREGOING CHAPTERS.

THE aliment being received into the mouth, is there masticated, and impregnated with saliva, which is pressed out of the salivary glands by the motions of the jaw and the muscles that move it and the tongue. Then it descends through the pharynx into the stomach, where it is digested by the juices of the stomach (which are what is thrown out of the glands of its inmost coat, and saliva out of the mouth) and a moderate warmth and attrition. Then it is thrown through the pylorus or right orifice of the stomach into the duodenum, where it is mixed with bile from the gall-bladder and liver, and the pancreatic juice from the pancreatic gland. These fluids serve farther to attenuate and dilute the digested aliment, and probably to make the fluid part separate better from the fæces. After this it is continually moved by the peristaltic motion of the guts, and the compression of the diaphragm and abdominal muscles, by which forces the fluid parts are pressed into the lacteals, and the gross parts through the guts to the anus.

The chyle, or thin and milky part of the aliment, being received into the lacteals from all the

small guts, they carry it into the receptaculum chyli, and from thence the ductus thoracicus carries it into the left subclavian vein, where it mixes with the blood, and passes with it to the heart.

All the veins being emptied into two branches, viz. the ascending and descending cava, they empty into the right auricle of the heart ; the right auricle unloads into the right ventricle, which throws the blood through the pulmonary artery into the lungs ; from the lungs the blood is brought by the pulmonary veins into the left auricle, and from that into the left ventricle, by which it is thrown into the aorta, and distributed through the body. From the extremities of the arteries arise the veins and lymphatics ; the veins to collect the blood and bring it back to the heart ; and the lymphatics to return the lymph, or thinner part of the blood, from the arteries to the veins and the vasa lactea, where it mixes with the chyle, and then passes with it into the left subclavian vein and to the heart.

All the fluids that pass into the stomach and guts being carried into the blood vessels, the greatest part of them are separated and carried off by proper vessels, viz. urine from the kidneys, bile from the liver, &c. and these juices carry along with them whatever might be injurious to the animal economy.

CHAPTER XIII.

OF THE DURA MATER AND PIA MATER.

DURA mater is a very compact, strong membrane, lining the inside of the scull, firmly adhering at its basis, and but lightly at the upper part, except at the sutures. It has three processes; the first, named falx, begins at the crista galli, and runs backwards under the suture sagittalis to the cerebellum, dividing the cerebrum into two hemispheres. Its use is said to be to support one side of the cerebrum from pressing on the other when the head is inclined to one side. But I think it is evident that this is not the use, because there would be more need of such a process from one side of the scull to the other, than this way; and it would also be very necessary that it should run through the brain, to answer that end. The principal use appears to me to be, to divide the brain into such portions as are least liable to be moved in the scull, by any violent motions of the head, which is better done this way than it would the other; and the under side of the brain is kept steady by the inequalities of the basis of the scull, which the brain is exactly fitted to. In brutes the falx is always very small, therefore in those whose brains are of the larger size, as oxen, sheep, horses, &c. the upper part of the scull is made uneven, exactly to fit the folds of the brain which secures

the upper parts of their brains from concussions, in the same manner that the lower parts are secured. The second process runs from the lower and back part of the former to the upper edge of each os petrosum, and sustains the posterior lobes of the cerebrum, that they might not compress the cerebellum. In such rapacious animals as I have dissected, this process is bone. The third is very small; it runs from the last described process down towards the great foramen of the scull, and possesses the small space in the cerebellum, between the processus vermiformis. These processes of the dura mater also serve to keep the brain steady.

The dura mater has in it several sinuses, which are large veins to receive the blood from the lesser veins of the brain: their number is uncertain, and those that are constant are not described in the same order by writers. The first that presents itself is the longitudinalis superior, running from a blind hole a little above the crista galli all along the upper edge of the falx. A transverse section of this vessel is not circular, like other vessels, but a triangle, whose sides are arches of a circle; the upper side convex outwards, and the two lower convex inwards. The figure of this vessel is preserved by small ligaments running across in the inside, that it might not become conical, or cylindrical, like other vessels, from the equal pressure of the contained blood, and thereby incommode the upper edges of each hemisphere of the cerebrum,

On the lower edge of this process is generally another very small one, called longitudinalis inferior; this runs into the rectus, and when wanting is supplied by a vein; the rectus runs between the two first processes of the dura mater, and unloads with the sinus longitudinalis superior into the two lateral sinuses; but for the most part the longitudinal sinus goes more directly into one of the lateral sinuses, and the straight sinus into the other. There is sometimes a small one in the third process, which empties in the same place with the former. From the endings of the longitudinal and straight sinuses, begin the two lateral sinuses, which, when they come to the os petrosum, dip down and pass through the eighth foramina into the internal jugular veins. There is another named circularis; it runs round the fore part only of the cella turcica; the two ends of this empty into four sinuses, one on the top of each os petrosum, which pass into the sinus lateralis, and one at the under sides of the same bones, which pass indifferently into both the lateral and cervical sinuses; these two last sinuses have always communicant branches. The cervical sinuses run from the basis of the scull through the great foramen on both sides of the medulla spinalis colli, and through the transverse processes of the cervical vertebræ; the last of these have many times proper foramina running from the eighth foramina to the back part of the apophyses of the occipital bone. There are also two more of these

vessels, which run from the circular sinus between the os sphenoides and fore part of the os petrosum directly into the internal jugular veins.

Pia mater is an exceeding fine membrane immediately investing the brain, even between its lobes, hemispheres, and folds. It serves to contain the brain, and support its blood vessels, which run here in great numbers, for the arteries to divide into small branches upon, that the blood may not enter the brain too impetuously: and for the veins to unite on, that they may enter the sinuses in fewer and larger branches. Between the dura and pia mater, is described, by several anatomists, a membrane called arachnoides, which may easily be shewn at the back part of the cerebrum, upon the cerebellum and back part of the medulla spinalis.

I have seen a large part of the dura mater, and once part of the pia mater ossified.

CHAPTER XIV.

OF THE CEREBRUM, CEREBELLUM, MEDULLA OBLONGATA, AND MEDULLA SPINALIS.

CEREBRUM is that part of the brain which possesses all the upper and fore part of the cranium, being separated from the cerebellum by the second process of the dura mater. Its upper side is divided into two hemispheres, and its lower side into four lobes, two anterior and two posterior, which latter are much the largest. At the meeting of the four lobes appears the infundibulum, which seems to be a lymphatic, running from the ventricles of the brain into the glandula pituitaria : this gland is seated in the cella turcica. Immediately behind the infundibulum appear two small bodies, named protuberantiæ duæ albæ pone infundibulum. Between the two hemispheres of the cerebrum, lower than the circumvolutions, appears a white body named corpus callosum. Under the corpus callosum appear the two lateral or superior ventricles, which are divided into right and left by a very thin membrane, named septum lucidum, which is extended between the corpus callosum and fornix. The fornix is a medullary body beginning from the fore part of these ventricles, with two small roots which soon unite ; and running towards the back part, where they divide into parts, called crura fornicis. In the

basis of these two ventricles are four prominences: The two anterior are called (from their inner texture) corpora striata; the other two are named thalami nervorum opticorum. Beyond these are two more processes, called nates; and under them, nearer the cerebellum, two called testes. Above the nates is situated the glandula pinealis, famous for being supposed by DES CARTES, the seat of the soul. And upon the thalami nervorum opticorum are a number of blood vessels, glands, and lymphæducts, called plexus choroides. Under the beginning of the fornix is a small hole, called foramen ad radices fornices, or iter ad infundibulum; and under the middle of the fornix, one called foramen posterius, which is covered with a valve named membrana, or valvula major; and the space under the two anterior ventricles between the foramina and the cerebellum is the third ventricle.

Cerebellum is situated under the second process of the dura mater. By dividing this part of the brain lengthways we discover more plainly the fourth ventricle, whose extremity is called calamus scriptorius; here also appear two medullary bodies called pedunculi, which are the basis of the cerebellum. The medullary part in the cerebellum, though it is inmost, as in the cerebrum, yet is of a different shape, being branched out like a plant.

The substance of the brain is distinguished into outer and inner: the former is called corticalis, cinerea, or glandulosa; the latter medullaris, alba, or nervea.

Medulla oblongata is a medullary continuation of the under part of the cerebrum and cerebellum. It first appears in two bodies from the anterior part of the posterior lobes of the cerebrum, called crura medullæ oblongatæ. The union of these crura between the cerebrum and cerebellum is called isthmus; and immediately beyond this is an eminence named processus annularis.

Medulla spinalis is a production of the medulla oblongata through the great foramen of the scull, and through the channel of the spine: it enlarges about the last vertebræ of the back and first of the neck, where the large nerves are given off to the arms: it again enlarges in the loins, where the crural nerves begin; and the lower end of it, with those and other nerves, is called from its resemblance cauda equina. The coats of this part are the same with those of the brain; but the membrane here, which is analogous to the dura mater, is thinner and more connected to the bones, and the tunica arachnoides more conspicuous.

Wounds in the cerebrum, though very dangerous, are not mortal; but in the cerebellum and medulla oblongata cause sudden death; and in the medulla spinalis, loss of sense in all the parts which receive nerves from below the wound. In persons that have died lethargic, I have always found the brain full of water: and in children, the brain is always very soft and moist. In a man, that died of an apoplexy, I found all the vessels of the brain

immoderately distended with blood, and the ventricles and the substance of the brain full of lymph, the pia mater very much thickened, and adhering so very loosely that the greatest part of it was separated without breaking.

I have twice seen in the cerebrum a scirrhous tumor as large as a pullet's egg; and in another body, imposthumations which possessed near two thirds of the whole cerebrum. And in a person that died with a gutta serena, I found all the ventricles of the brain full of lymph; and the thalami nervorum opticorum and the optic nerves, ere they went out of the scull, made flat with the pressure. And in an old man I found the right optic nerve wasted and black.

CHAPTER XV.

OF THE NERVES.

" FROM the medullary part of the cerebrum, " cerebellum, and medulla spinalis, a vast num- " ber of small medullary white fibres are sent " out, which, at their first egress, seem easily to " separate, but as they pass forward are somewhat " more, but still loosely connected, by the coat " which they obtain from the pia mater, and at " last piercing the dura mater, are straitly braced " by that membrane which covers them in their " progress; whence they become white, firm,

" strong cords, and so, are well known by the
" name of nerves. To these coats an infinite num-
" ber of vessels, both arteries and veins, are dis-
" tributed ; so that after a nice lucky injection the
" whole cord is tinged with the colour of the in-
" jected liquor : but when the fibrils are examined,
" even with the best microscope, they appear only
" like so many small distinct threads running pa-
" rallel, without any cavity observable in them,
" though some incautious observers, mistaking the
" cut orifices of the arterious and venous vessels,
" just now mentioned, for nervous tubes, have af-
" firmed their cavities to be visible. The nerves,
" which if all joined hardly make a cord of an inch
" diameter, would seem, from their exerting them-
" selves every where, to be distributed to each, even
" the smallest part of the body. In their course
" to the places for which they are destined, they
" generally run as straight as the part over which
" they are to pass, and their own safety from exter-
" nal injuries, will allow, sending off their branch-
" es at very acute angles, and consequently run-
" ning more parallel than the blood vessels. Their
" distribution is seldom different in the opposite
" sides of the same subject, nor indeed in any
" two subjects is there considerable variety found.
" Frequently nerves which come out distinct or
" separate, afterwards conjoin into one fasciculus,
" under the same common covering ; and though
" the nervous fibrils probably do not communicate

" (the reason of which opinion shall immediately " be given) yet because the coats at the conjoined " part are common, and these strong coats may " have great effects on the soft pulpy nerves, it is " evident all such will have a considerable sympa- " thy with one another, whereof several exam- " ples in practice shall be instanced when the par- " ticular nerves are described. In some parts " where there are such conjunctions, the bulk of " the nerves seems much increased, and these " knotty oval bodies, called by FALLOPIUS cor- " pora olivaria, and generally now named gang- " lions, are formed. The coats of these knots " are stronger, thicker, and more muscular than " the whole nerves which enter into them would " seem to constitute, while the nervous fibrils " pass through without any great alteration or " change. I do not think any author has yet " made a probable conjecture of the use or design " of these ganglions, whether they imagine them " corcula expellentia, reservoirs, or elaboratories, " neither can I give an account of their use the " least satisfactory to myself.

" From undeniable evident experiments, all an- " atomists are now convinced that to the nerves " we owe all our sensation and motion, of which " they are the proper organs; and the sensations " in the minutest parts being very distinct, there- " fore the instruments of such sensations must have " distinct origins and course to each part. Though

" all are agreed as to the effect, yet a hot dispute
" has arisen about the manner how it is produced,
" viz. whether sensation and motion are occasioned
" by a vibration communicated to the nerves, which
" these gentlemen suppose entirely solid and tense,
" or by a liquid contained and moved in them.
" The last of these opinions I rather incline to, for
" these reasons, because the nerves proceeding from
" the brain bear a great analogy to the excretory
" ducts of other glands. Then they are far from
" being stretched and tense in order to vibrate.
" And what brings the existence of a liquid in their
" cavities next to a demonstration is the experiment
" first made by BELLINI, and related by BOHN
" and PITCAIRN, which I have often done with
" exact good success; it is this: After opening the
" thorax of a living dog, catch hold of and compress
" the phrenic nerve, immediately the diaphragm
" ceases to act; remove the compressing force, that
" muscle again contracts; gripe the nerve with one
" hand some way above the diaphragm, that sep-
" tum is unactive; then with the other hand strip
" down the nerve from the first hand to the dia-
" phragm, this muscle again contracts; after once
" or twice having stripped the nerve thus down
" or exhausted the liquid contained in it, the mus-
" cle no more acts, squeeze as you will, till the
" first hand is taken away or removed higher, and
" the nerve stripped, i. e. the liquids in the supe-
" rior part of the nerve have free access to the dia-

" phragm, or are forced down to it, when it again " will move. Now if this liquid should be granted " us, I am afraid we shall be still as much at a " loss to account for sensation and motion as ever ; " and therefore all I shall assume is what is found- " ed on experiments, that these two actions do de- " pend on the nerves ; that sensations are pleasant " as long as the nerves are only gently affected " without any violence offered them ; but as soon " as any force applied goes beyond this, and " threatens a solution of union, it creates that " uneasy sensation, pain : the nerves, their source " or their coats being vitiated, either convulsion or " palsy of the muscles may ensue.

" The nerves are distinguished into two classes, " of the encephalon and medulla spinalis ; of the " first there are generally ten pair reckoned, of " the last thirty. I shall describe the nerves in " the same order in which they are generally " ranked, though it is not possible to prosecute the " dissection of them after the same manner ; but " to supply this, I shall mention also the order " wherein they may be all demonstrated on one " subject. When I assign the origin of any nerve " from any particular part, I desire it may be un- " derstood of that part of the surface of the me- " dulla, where the nerve first appears ; for by this " method we shall shun any dispute with those au- " thors who trace their rise too minutely, and per- " haps be less liable to mistake or to deceive our

" readers. Nor shall I be over anxious about the " terminations of the minimæ fibrillæ, since it is " not possible to trace them ad ultimos fines, nor " do I think it very necessary for explaining any " phænomena, while very often in a multiplicity of " words the whole description comes to be obscure " or unintelligible.

" Of the ten pair proceeding from the encepha- " lon, the first is the olfactory, which in brutes, " justly enough, has the name of processus ma- " millares bestowed on them, being large and hol- " low, and are indeed evidently the two anterior " ventricles of the brain produced ; which structure " and the lymph constantly found in them, induced " the ancients to believe that they served as emunc- " tories to convey the superabundant mucus from " the cold moist brain to the nose ; but in man " they are small, long, and without any cavity, " rising from that part of the brain where the ca- " rotid arteries are about to enter, and running un- " der the anterior lobes of the brain become a little " larger, till they reach the os tribriforme, into " the foramina of which the small filaments in- " sinuate themselves, as upon gently pulling those " nerves, or after having cut them very near the " bone, is evident, and are immediately spread on " the membrana narium. Their tender structure " and sudden expansion on such a large surface, " make it impossible to trace them on the mem- " brane of the nostrils, which has given some handle

" to several authors to deny them the structure or
" use of nerves.

" The second are the optic, which arise single
" from the thalami nervorum opticorum, and then
" uniting at the fore part of the cella turcica, they
" seem to be pretty much blended ; afterwards they
" divide, and running obliquely forwards, pass out
" at their proper hole of the sphenoide bone, and
" enter the globe of the eye to be expanded into
" the membrana retina. From this conjunction of
" these nerves, authors generally endeavour to ac-
" count for our seeing objects single, whereas we
" have reason to believe fishes, the chamæleon, &c.
" whose optic nerves simply cross one another with-
" out any such union, do see objects also single,
" since they so exactly rush on their prey ; where-
" as if those authors' assertions were true, they
" would oftener catch at the shadow than the sub-
" stance. The blood vessels running through the
" middle of these nerves, and the ramifications of
" the retina are very observable, whence we may
" deduce the reason of PICARD's experiment of
" such objects as fall on the entry of the optic nerve
" being lost to us ; and hence also an account may
" be given of an amaurosis or gutta serena.

" The third pair of nerves first appear at the
" anterior part of the processus annularis, and go-
" ing out at the foramen lacerum, are distributed to
" the globe of the eye ; musculus rectus Fallopii,
" attolens, adducens, deprimens, and obliquus mi-

" nor ; therefore this pair has justly got the name
" of motores oculi.

" The fourth pair, which are the smallest of
" any, derive their origins from the anterior lateral
" part of the processus annularis, and go out at the
" foramina lacera to be entirely spent on the mus-
" culi trochleares, or obliqui majores oculorum,
" to which muscles chiefly the rotatory motion of
" the eyes in ogling, and the advance of the eyes
" forward in staring and fury, is owing ; for
" which reason anatomists have called these nerves
" pathetici.

" The fifth pair arise from the sides of the an-
" nular process, and after piercing the dura mater
" divide into three branches ; the first of which is
" the ophthalmic, which as it is about to enter
" the orbit by the foramen lacerum, sends off a
" small twig that assists in the formation of the
" intercostal, and then the nerve is distributed to
" the glandula lacrymalis, fat membranes, and pal-
" pebræ of the eye, while it sends one considerable
" branch through the orbiter internus anterior hole
" to be lost in the membrana narium, and a second
" passes the foramen and supercilia to supply the
" muscles and teguments of the forehead. Hence
" we easily discover what part is affected in that
" painful disease the megrim, when the eyeball
" and forehead are racked, and such a heat is felt
" within the nose. Hence also we may learn how
" the muscles of respiration come to be so much

“ affected on the application of any acrid irritating
“ substance to the membrana narium, as to pro-
“ duce that violent convulsive motion, sneezing.
“ The second branch of the fifth pair, which may
“ be called maxillaris superior, passes out through
“ the foramen rotundum ossis sphenoidis, and im-
“ mediately gives nerves to the fat under the cro-
“ taphite muscle, and to the palate, sinus sphenoi-
“ dalis, and nostrils. The remaining trunk insinu-
“ ating itself into the channel on the top of the
“ antrum Highmorianum, to which cavity and to
“ the teeth of the upper jaw it gives small twigs,
“ at last comes out at the orbiter externus hole,
“ and is spent on the musculus orbicularis palpebra-
“ rum, nose, and upper lip, where some branches
“ of the seventh pair seem to unite themselves to
“ the twigs of this. The third branch, or maxil-
“ laris inferior, goes out at the foramen ovale, or
“ fourth hole of the wedge-like bone, and soon
“ splitting into a great many branches, is distrib-
“ uted to the musculus crotaphites, masseter, pte-
“ rygoides, digastricus, buccinator, mylohyoideus,
“ geniohyoideus, genio-glossus, and basio-glossus,
“ glandula sublingualis, maxillaris inferior, and pa-
“ rotis, to the external ear, where it seems to join
“ the portio dura to the substance of the tongue,
“ in which it is pretty much confounded with the
“ ninth pair : from the root of this last branch the
“ chorda tympani is reflected. The last ramifica-
“ tion of this branch which I shall mention, is

" that which enters into the canal of the lower jaw " furnishes the teeth there, and comes out at the " chin, on which and the lower lip it is bestowed; " at this place it is again conjoined to the seventh " pair. From this short sketch of the large fifth " pair of nerves, and by observing several phænom- " ena which happen to those parts to which they " are distributed, we might have a much farther " confirmation of the general doctrine of nerves " delivered, and see, at least, the way pathed to a " rational account of these phænomena, for reason- " ing on which we should not otherwise have the " least ground. We can, for example, from the " chorda tympani and the nerves of the teeth, be- " ing derived from the same common trunk, un- " derstand how the sound of any vibrating body " held between our teeth is sensible to us, when " another cannot possibly hear the least of it. By " the like rule we know why in a violent tooth- " ache the muscles of the face are somtimes con- " vulsed; nor shall we be surprised to hear one " plagued with the ache in his upper teeth, com- " plain of a gnawing pain deep seated in the bones " of his face, or to see his eyelids much swelled, " or the tears trickling down in great abundance; " whereas the lower teeth aching, the ear is pain- " ed, and the saliva flows in great quantities. We " may have some distant views of some foundation " in reason for the cure of the toothache, by strong " compression of the chin, or by applying blisters

" behind the ears, or by burning behind or on the " ear. Among a great many instances of the good " effect of the actual cautery in such a case, I shall " give one which seems to be remarkable: I. M. " was seized with the toothache, a convulsion of " that whole side of his face followed whenever " the pain became acute, or he attempted to " speak; after he had undergone bleeding, purg- " ing, salivation, setons, &c. without any benefit, " he was cured by applying a small cauterising " iron to the antihelix.

" The sixth pair of nerves arising from the fore " part of the corpora pyramidalia, after piercing " through the dura mater, give off a branch, " which, joined with the reflected twig of the oph- " thalmic branch of the fifth pair, forms the origi- " nal of the intercostal, passes through the fora- " men lacerum to be spent entirely on the mus- " culus abductor oculi: supposing this nerve to " supply ever so little less than a due proportion " of liquidum nervosum, an involuntary strabis- " mus will be occasioned.

" Though the fifth and sixth pair of nerves " form entirely the beginning of the intercostal be- " fore it goes out of the scull, yet because several " other nerves contribute towards the formation of " its trunk before it sends off any branches, I shall " supersede the description of it till the original " nerves are spoke to.

" The seventh pair appears coming out from
" the side of the root of the annular process, and
" entering the meatus auditorius internus, and
" immediately dividing, one part soon loses its
" firm coats, and is expanded on the inmost ca-
" mera of the ear, while the other passing through
" the aquæductus Fallopii comes out of the scull
" involved in all its coats between the styloide and
" mastoide processes; whence we see the reason of
" the first being named portio mollis, and the
" other dura: this last after its exit supplies the
" musculi obliqui capitis stylohyoidei, styloglossi,
" and stylopharyngæi, and platysma myoides, on
" which, and to the skin of the neck, a great num-
" ber of its small filaments run, which are some-
" times cut in opening the jugular vein, whence
" pain at first, and a little numbness afterward.
" The superior branches of it supply the parotid
" gland, external ear, and whole side of the face
" as far forwards as the chin. It is said to com-
" municate thrice with the fifth pair, and twice
" with the second vertebra. Whether may not we
" hence see some reason why the head is so soon
" moved by the impression of sound on our ear?

" The eighth pair of nerves derive their origin
" from the side of the basis of the corpora olivaria,
" where their loose filamentous texture is very con-
" spicuous; then running to the hole common to
" the ossa temporum and occipitis, they are there
" joined by the accessorius Willisii, which has its

" beginning from the two or three superior nerves
" of the medulla spinalis, and mounts upwards
" thither, to pass out with the eighth pair, at that
" common foramen just now mentioned : very
" soon after they, wrapped up in the same coat,
" have got out of the cranium, the accessorius sep-
" arates from its companion, and after passing
" through the middle of the musculus mastoideus,
" is lost in the musculus trapezius and rhomboides
" scapulæ ; while the large trunk, which, from the
" great number of branches it sends off, obtains
" the name of vagus, runs straight down the neck,
" near the carotid artery, in its course giving seve-
" ral branches to the larynx : when entered the
" thorax, it splits into two ; the anterior serves the
" pericardium, sends branches to join with those
" of the intercostal that go to the heart, and then
" on the right side turns round the subclavian, and
" on the left round the ductus arteriosus, to mount
" again upwards at the side of the œsophagus to
" be lost in the larynx. This recurrent branch it
" is that we are earnestly cautioned to avoid in
" bronchotomy, though by reason of its deep situ-
" ation we are in no hazard of it. If both these
" nerves were cut, it is probable the voice would
" not be entirely lost as long as the superior branch-
" es still supply the larynx. The posterior branch
" of the eighth pair goes along with the œsophagus,
" and supplies the lungs, the gula, and stomach
" very plentifully ; and as all the nerves bestowed

"on this viscus enter at the superior orifice of it, "the sensation here must be very acute; whence "HELMONT imagined the mouth of the stomach "to be the seat of the soul. What remains of "this par vagum is adjoined to the intercostal im- "mediate below the diaphragm.

"The ninth pair appear first at the inferior "part of the corpora pyramidalia, and march out "at their proper holes of the occipitis, and after "sending off some nerves to the glandula thyroi- "dea, and musculi sterno-hyoidei, and sterno- "thyroidei, are lost in the substance of the tongue. "Authors have disputed whether this ninth or "the fifth is the gustatory nerve; the old opinion "in favour of the ninth is to me most probable, "because the fifth is no where else employed as "an organ of sensation, because the ninth seems to "penetrate the substance of the tongue more, while "the fifth is spent on the muscles.

"The tenth pair comes out from the beginning "of the medulla spinalis, betwixt the os occipitis "and first vertebra colli, and is all, except what "goes to the ganglion of the intercostal, spent on "the musculi obliqui, and extensores capitis.

"The only nerves proceeding from the ence- "phalon not described, are the reflected branches "of the fifth and sixth, which indeed are so small "and pappy, and hid by the carotid artery as they go "out with it in its crooked canal, as not to be easily "traced; but whenever they have escaped from the

" os petrosum, they are joined by branches from
" the eighth, ninth, tenth, and first and second
" spinal, and the largest ganglion of the body is
" formed, from which the nerve named now in-
" tercostal, goes out to descend down the neck
" with the carotid, supplying in its course the mus-
" culi flexores of the head and neck, and commu-
" nicating with the cervical nerves. As the inter-
" costal is about to enter the thorax, it again forms
" a ganglion, from which the nerves to the trachea
" arteria and the heart are supplied, which join with
" the branches of the eighth, and pass between the
" two large arteries and auricles to the substance
" of that muscle. Now let any one consider the
" egress of the intercostal, and close course of it
" and the eighth with the carotid artery, and this
" manner of entry of the cardiac nerves, surely
" the alternate constriction and relaxation of the
" heart will appear necessarily depending on the
" disposition of these organs of motion, the nerves.
" The intercostal after this runs down on the side
" of the vertebræ thoracis, having additional nerves
" constantly sent to it from between these verte-
" bræ, till it pass through its own proper hole of
" the diaphragm; whence it again forms another
" ganglion close by the glandulæ renales, into
" which the eighth pair enter. From such a knot
" on each side, the nerves of the guts, liver, spleen,
" pancreas, and kidneys are derived; nay, the ex-
" tremity of this nerve is sent down to the pelvis

"to supply the parts there. Hence the great sym-
"pathy of these parts may be easily deduced, and
"a reason may be given of the violent vomiting
"that commonly attends a nephritis, and of the
"belching, colic, and stomach aches, which often
"ensue on the obstructions of the menstrua.

"Before I proceed to the spinal nerves, I
"shall set down the order in which these nerves
"already described, are to be dissected, in order
"to demonstrate them all in one subject, but to
"them must assume the three first cervical nerves,
"the reason of which will be evident afterwards.

"Portio dura septimi, frontalis quinti, facia-
"lis quinti, mentalis quinti, spinalis secundus,
"spinalis primus, olfactorius, ophthalmicus quin-
"ti, motorius oculi, patheticus sextus, opticus,
"maxillaris inferior quinti, maxillaris superior
"quinti, accessorius Willisii, nonus, decimus, oc-
"tavus intercostalis, portio mollis septimi.

"The thirty pair of nerves proceeding from
"the medulla spinalis are generally divided into
"four species; of the neck seven, of the back
"twelve, of the loins five, and of the os sacrum
"six. Now as the medulla spinalis has none of
"these inequalities so observable on the medulla
"oblongata encephali, the rise of the nerves is not
"so accurately described, being only determined by
"the bone through which they pass.

"The first cervical goes out between the first
"and second vertebra, and, after sending off branches

" that communicate with the tenth and second " vertebrale, is spent on the musculus flexus colli, " splenius, complexus, and teguments of the occi" put.

" The second cervical communicates with the " ninth, and with the first and third of the neck, " and then is distributed to the teguments of the " neck and side of the head, and to the glandula " parotis and external ear, where it joins with the " portio dura.

" The third of the neck passes out between the " third and fourth vertebra, soon communicating " with the second, and sending down a large " branch, which being joined by another from " the fourth forms the phrenic nerve that runs " along the pericardium to be lost in the dia" phragm. In this course the right phrenic is o" bliged to make a small turn round that part of the " pericardium which covers the apex of the heart. " Hence it is that such as have strong palpita" tions of the heart feel a pungent acute pain im" mediately above the right orifice of the stomach. " The other branches of this third cervical are " distributed to the musculus trapezius and del" toides, and to the teguments on the top of the " shoulder; which, with the description of the " eighth pair, leads us evidently to the reasons of " the divine HIPPOCRATES's observation, that an " inflammation of the liver is generally attend" ed with a hiccough, and a suppuration of that

"viscus, with a violent pain on the top of the "shoulder. However, we are not hence to con-"clude so generally, as I have observed physicians "frequently do, that if the hypochondria are ef-"fected, and this pain of the shoulder is felt, there-"fore the liver is suppurated ; for any other cause "stimulating or stretching the nerves, such as in-"flammation, wounds, scirrhous or steatomatous "tumours, &c. may produce the same effect.

"The fourth cervical, after sending off that "branch which joins with the third to form the "phrenic, runs straight to the axilla, where it "meets with the fifth, sixth, and seventh cervicals, "and first dorsal that escape in the interstices of the "musculi scaleni ; and all of them are so often "conjoined and blended, after they have given off "nerves to the muscles of the neck, scapula, arm, "and thorax, and to the teguments, that when the "several ramifications go off in the axilla to the "different parts of the superior extremity, it is im-"possible to determine which of them the branches "belong to. The considerable branches into which "they are divided, are six ; these I shall presume to "give proper distinguishing names to, by which the "description will be less confused, and the young "anatomist's memory better assisted to retain what "is so difficult to represent in words.

"1. Cutaneus runs down the fore part of the "arm, and serves the teguments, as far as the palm "of the hand and fingers.

" 2. Musculo-cutaneus, or perforans casserii, " passes through the musculus coracobrachialis, and " after supplying the biceps and brachiæus internus " is spent on the teguments of the back of the cu- " bitus and hand.

" 3. Muscularis, that runs down the fore part " of the arm to be lost in the musculi flexores carpi, " digitorum, &c.

" 4. Ulnaris, which supplies the extensores " cubiti, and teguments of the elbow, and then " passing through the sinuosity at the back of the " external condyle of the humerus, runs along the " ulna, where it gives twigs to the teguments and " neighbouring muscles; at length is lost in the " back of the hand, musculi interrossei, and lumbri- " cales in the little finger, and side of the ring " finger next to this. The course of this nerve is " sufficiently felt when we lean on our elbow, by " the insensibility and prickling pain in the parts " to which it is distributed.

" 5. Radialis goes down the fore part of the " arm, near the radius, bestowing branches in its " progress on the circumjacent muscles, and at the " ligamentum annulare carpi splitting, is sent to " the thumb, fore finger, middle finger, and half " the ring finger, and to the back of the hand.

" 6. Articularis runs almost round the top of " the os humeri, and serves the musculi exten- " sores cubiti, retractores, and elevatores humeri.

" By a strong and continued pressure on these " nerves, by crutches or any such hard substance, " a palsy and atrophy of the arm may be occa- " sioned.

" The twelve dorsal nerves all communicate " with one another : as soon as they make their " way out betwixt the vertebræ, each of them " gives a posterior branch to the musculi erectores " trunci corporis ; the first, after having sent off " the brachial nerve, already described, is, after the " same manner with the succeeding eight, be- " stowed on the pleura and intercostal muscles ; the " tenth and eleventh are most of them sent to the " abdominal muscles ; the twelfth communicates " with the first lumbar, and is bestowed on the " musculus quadratus lumbalis and iliacus internus.

" The fifth lumbar also communicates and gives " posterior branches ; the first sends several branches " to the abdominal muscles, and psoas, and iliacus, " while others go from it to the teguments and " muscles on the superior and anterior part of the " thigh, and the main trunk of it is lost in the " crural. The second passes through the psaos " muscle, and is distributed much as the former. " The third is lost in the musculus pectineus. " Branches proceeding from the first, second, and " third, make up one trunk, which runs along the " anterior part of the pelvis, and slipping through a " small sinuosity in the anterior part of the foramen " magnum ossis ischii, is spent in the musculus

"triceps. This nerve is commonly known by the "name of obturator, or posterior crural nerve. "By the union of branches from the first, second, "third, and fourth lumbar nerves, the anterior "crural nerve is formed, which running along the "musculus psoas, escapes with the large blood "vessels, out of the abdomen below the tendinous "arcade of its muscles, and is distributed to the "muscles and teguments on the fore part of the "thigh: one branch of this crural nerve accom-"panies the vena saphena as far as the ancle. Now "let us imagine the situation of the kidney upon, "and the course of the ureter over these nerves, "and we shall not be surprised, that in a nephritis "the trunk of the body cannot be raised erect "without great pain; that the thigh loses of its "sensibility, and that it is drawn forwards. The "remainder of the fourth and the fifth lumbar "nerves join with the first, second, and third that "proceed from the os sacrum: these five, when "united, constitute the largest nerve of the body, "so well known by the name of the sciatic, or "ischiatic nerve, which seems to be bigger, in "proportion to the part for the use of which it is, "than the nerves of any other part are; the de-"sign of which may be to afford sufficient strength "to the muscles of the lower extremity, for ex-"erting a force superior to what is required in any "other part of the body. When this nerve is any "way obstructed, we see how unable we are to

" support ourselves, or to walk. The sciatic nerve
" then goes out at the large hollow behind the
" great tubercle of the os ischium, and passing
" over the quadrigemini muscles, runs down the
" posterior part of the thigh, giving off, every
" where as it goes, nerves to the teguments and
" muscles of the thigh and leg. At the ham it
" splits into two ; the smaller mounts over the fi-
" bula, and serving the musculi peronei, flexores
" pedis, and extensores digitorum, is continued to
" the toes along the broad of the foot, while the
" larger trunk sinks under the musculi gemelli,
" and then divides ; one is spent in the muscles
" at the back of the leg and teguments, while
" the other is continued by the inner ancle to the
" foot, and then subdivides ; one branch is distrib-
" uted after the same manner as the ulnaris, and
" the other as the radialis in the hand.

" The other nerves that come out of the os sa-
" crum, are sent to the organs of generation, mus-
" culi levatores ani, and obturatores.

" These nerves of the medulla spinalis may all
" be dissected and demonstrated in the same order
" in which they are described." For this accurate
description of the nerves I am obliged to Mr.
Monro.

The nerves seem, when examined with a mi-
croscope, to be bundles of strait fibres not commu-
nicating with one another : and I am inclined to
think, that every the minutest nerve terminating

in any part, is a distinct cord from its origin in the brain or spinal marrow; or else I do not see how they could produce distinct sensations in every part: and the distinct points of sensation throughout the body are so very numerous, that the whole body of nerves (which taken together would not make a cord of an inch diameter) must be divided into such a number, to afford one for every part that has a distinct sensation, that surely such a nerve would be too small to be seen by the best microscope. They all pass in as direct courses to the places they serve, as is possible, never separating nor joining with one another but at very acute angles, unless where they unite in those knots which are called ganglions, the use of which I do not pretend to know; they make what appears to be a communication of most of the nerves on the same side, but never join nerves on opposite sides.

That the nerves are instruments of sensation, is clearly proved from experiments, but how they convey those sensations to the brain, is matter of dispute. The most general opinion is; that they are tubes to contain animal spirits, by whose motions these sensations are conveyed: and diligent inquiry has been made to discover their cavities, but hitherto in vain; and if each nerve is distinct from its origin, as I have endeavoured to shew, and too small to be the object of the best microscope, I do not see how such cavities are like to be discov-

ered. Nevertheless nerves may be tubes, and possibly a fluid, whose cohesion is very little, and whose parts, no finer than light, may move freely in them. Those who deny animal spirits in the nerves, suppose that the sensation is conveyed by a vibration. To which it is objected, that they are slack, moist, and surrounded with soft parts, and are therefore unfit for vibrations, as indeed they are for such as are made on the strings of a musical instrument; but the minutest vibrations, such as they cannot be without, may, for aught we know, be as sufficient for this end, as the impulse of light upon the retina, is for the sense of seeing. So that perhaps sensations may be conveyed either, or both ways. However, it being usually taken for granted, that it must be one of these ways at least, the advocates for each have rather endeavoured to support their opinions by arguments against the probability of the other, than by reasons offered for their own.

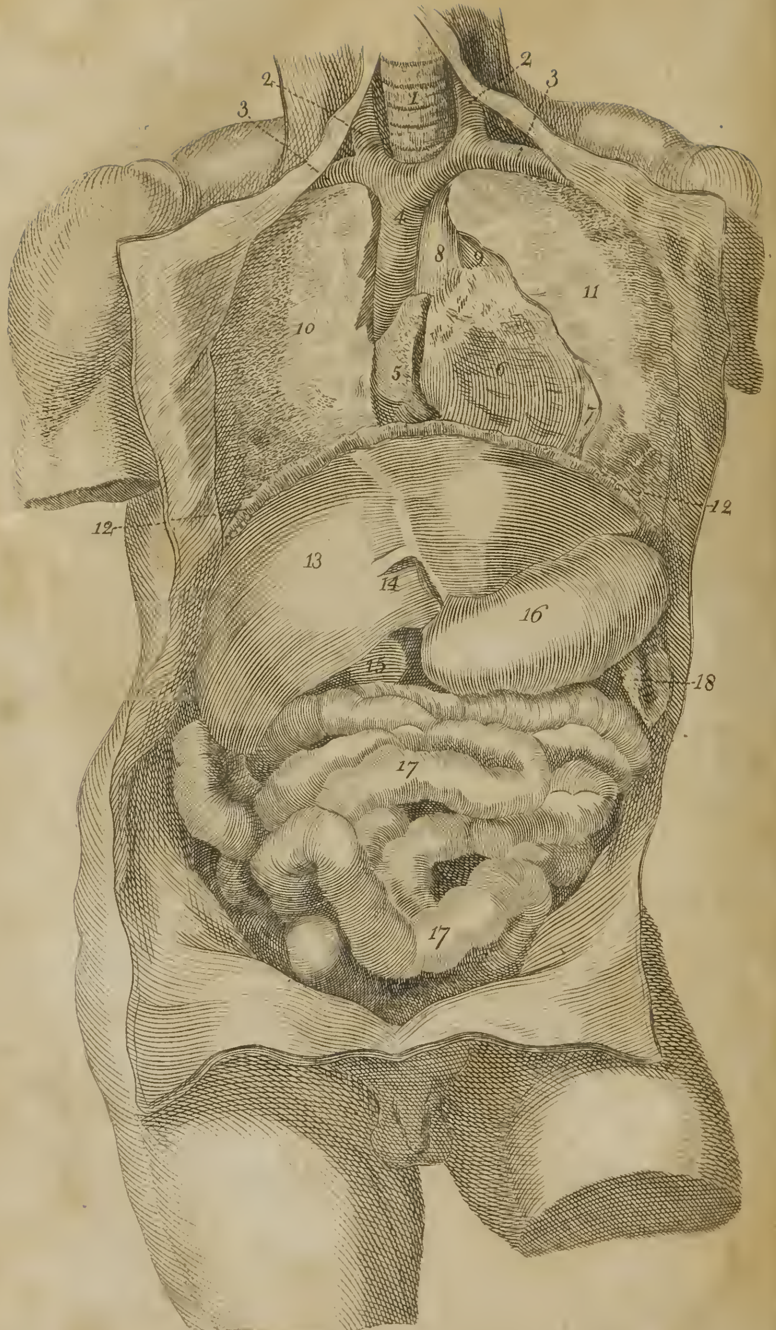

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TABLE XXI.

1 Larynx.
2 The internal jugular vein.
3 The subclavian vein.
4 Cava descendens.
5 The right auricle of the heart.
6 The right ventricle.
7 Part of the left ventricle.
8 Aorta ascendens.
9 Arteria pulmonalis.
10 The right lobe of the lungs, part of which is cut off to shew the great blood vessels.
11 The left lobe of the lungs.
12 The diaphragm.
13 The liver.
14 The ligamentum rotundum.
15 The gall-bladder.
16 The stomach, pressed by the liver towards the left side.
17 The small guts.
18 The spleen.

TABLE XXII.

1 The under side of the liver.
2 Ligamentum rotundum.
3 The gall-bladder.
4 The pancreas.
5 The spleen.
6 The kidney.
7 Aorta ascendens.
8 Vena cava ascendens.
9 The emulgent vein.
10 A probe under the spermatic vessels and the arteria mesenterica inferior, and over the ureters.
11 The ureter.
12 The iliac vessels.
13 The rectum intestinum.
14 The bladder of urine.

TAB. XXII.

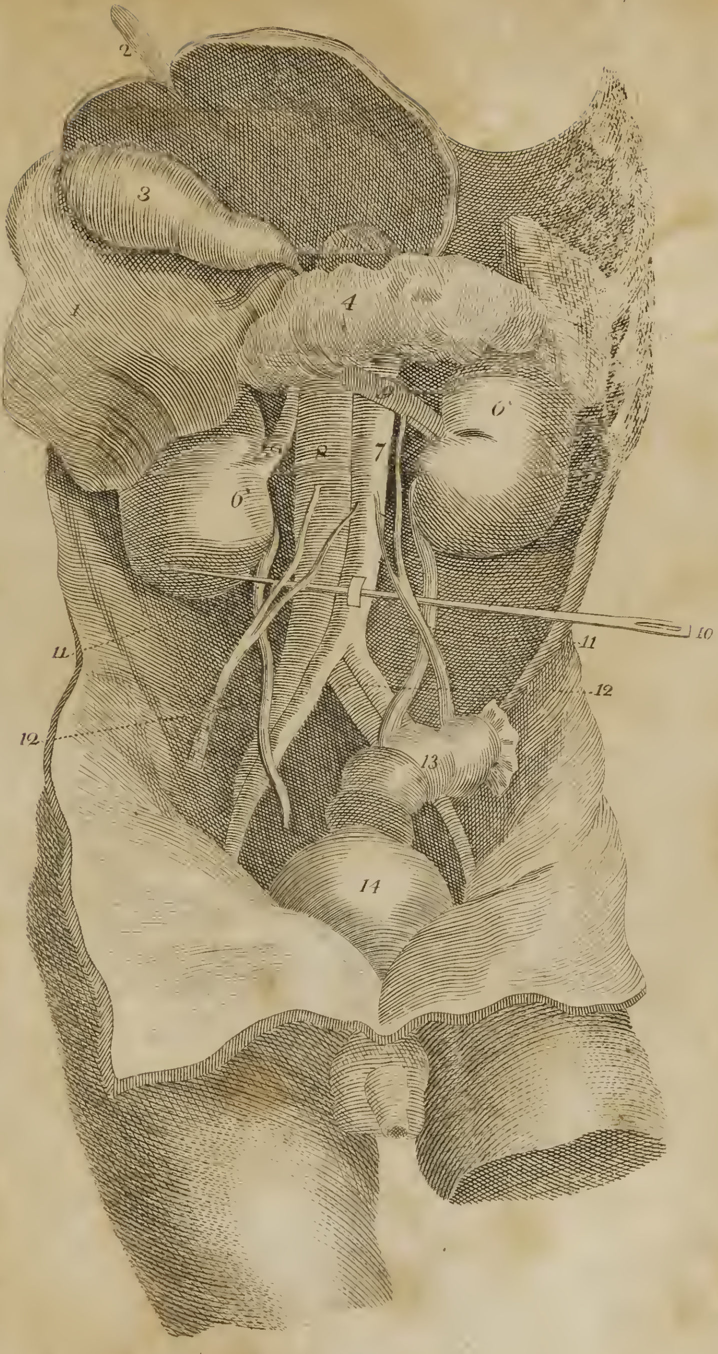


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TABLE XXIII.

1 Part of the intestinum jejunum.
2 The valvulæ conniventes, as they appear in a dried preparation.
3 The venæ lacteæ arising from the gut, and passing through part of the mesentery.
4 Part of the descending aorta.
5 Arteria cœliaca.
6 Mesenterica superior.
7 Emulgentes.
8 Spermaticæ.
9 Some of the branches of the mesenterica inferior that are bestowed upon the guts.

TABLE XXIV.

1 Extreme branches of the vena porta, as they arise from the guts.

2 All the branches of the vena porta, united before it enters the liver.

3 The branches of the vena porta, as they are distributed in the liver.


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TABLE XXV.

1 Branches of the vena cava in the liver.
2 Part of the vena cava ascendens.
3 Part of the right auricle.
4 Cistis hepatica.
5 Ductus sisticus.
6 Ductus hepaticus.
7 Ductus pancreaticus.
8 The entrance of the ductus communis into the duodenum.

TABLE XXVI.

1 The left subclavian vein.
2 The internal jugular.
3 Part of the vena azygos.
4 Part of the descending aorta.
5 The subclavian artery.
6 Some of the lacteals entering the receptaculum chyli.
7 Some lymphatics entering the receptaculum chyli.
8, 9 The Ductus thoracicus.
10 The entrance of the thoracic duct into the subclavian vein.

TAB. XXVI.


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TABLE XXVII.

1 The humeral artery.

2 Cubitalis superior.

3 Cubitalis inferior, which ends in the hand and the fingers, and communicates with the cubitalis superior, under the muscles of the thumb.

4 The place where the cubitalis media is given off.

5 The superior cubital nerve.

6 The inferior cubital nerve, which passes under the inner extuberance of the os humeri; both these nerves give off branches as they pass, and end in the thumb and fingers.

TABLE XXVIII.

1 Part of the biceps flexor cubiti.

2 The fascia tendinosa from that muscle, which is liable to be pricked in bleeding in the basilic vein.

3 The humeral artery, on each side of which is a large vein.

4 Vena cephalica.

5 Mediana.

6 Basilica.

7 A tumor formed in the centre of the cubital nerve, a little above the bend of the arm; it was of the cistic kind, but contained a transparent jelly; the filaments of the nerve were divided and ran over its surface. This tumor occasioned a great numbness in all the parts that nerve leads to, and excessive pain upon the least touch or motion. This operation was done but a few weeks since, the pain is entirely ceased, the numbness a little increased, and the limb, as yet, not wasted.


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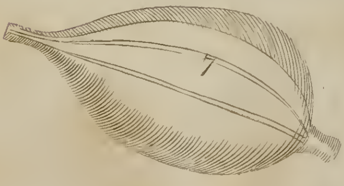
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TABLE XXIX.

1 The medulla spinalis, from whence arise the nerves that pass out between the vertebræ.
2 The brachial nerves.
3 The beginning of the cauda equina.
4 The anterior crural nerves.
5 The posterior crural nerves.
6 The descending intercostal.
7 Nerves of the neck.
8 The brachial nerves.
9 A ganglion in the descending intercostal nerve.
10 Branches from the intercostal nerve to the viscera.
11 A probe passed under some of the intercostal nerves that pass out between the ribs.
12 The anterior crural nerves.

TABLE XXX.

1 The animalculæ in semine masculino, as they appeared in a microscope, in a space as small as a pin's head.

2 The circulation of the blood in a fish's tail, as it appeared in a microscope.

3 An artery, as it is spread in a membrane.

4 A vein, as it is spread in a membrane.


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THE

ANATOMY

OF THE

HUMAN BODY.

BOOK IV.

CHAPTER I.

OF THE URINARY AND GENITAL PARTS OF MEN, TOGETHER WITH THE GLANDULÆ RENALES.

THE urinary parts are the kidneys with their vessels and bladder of urine.

The kidneys of men are like those of hogs; the two weigh about twelve ounces; they are seated towards the upper part of the loins upon the two last ribs; the right under the liver, and a little lower than the other, and the left under the spleen. Their use is to separate the urine from the blood, which is brought thither for that purpose

by the emulgent arteries; and what remains from the secretion, is returned by the emulgent veins, while the urine secreted is carried off through the ureters to the bladder. I have, in three different subjects, taken stones out of the loins, which had made their ways from the kidneys through the muscles to the common integuments, where upon opening the skin only, the stones appeared with a quantity of matter and urine. We have heard of operators who have cut for the stone in the kidneys; but I will venture to affirm, that those cases were no other than these, though unfairly related.

The ureters are tubes about the bigness of goose-quills, and about a foot long; they arise from the hollow side of the kidneys, and end in the bladder near its neck, running obliquely for the space of an inch between its coats; which manner of entering is to them as valves. The beginning of the ureters in the kidneys are the tubuli urinarii, which joining form the pelvis in each kidney. Between the tubuli urinarii, authors have remarked small papillæ; and the parts which are distinguished by a clearer colour they call glandulæ.

The bladder of urine is seated in a duplicature of the peritonæum in the lower part of the pelvis of the abdomen; its shape is orbicular, and its coats are the same with those of the guts and other hollow muscles already described; viz. an external membranous, a middle muscular, which is the musculus detrusor urinæ, and an inner membranous

coat, exceeding sensible, as is fully shewn in the cases of the stone and gravel. The use of this nice sense is to make it capable of that uneasiness which excites animals to exclude their water, when the bladder is extended. This sense is so delicate, that no fluid but natural urine can be long endured, even pale urine, or urine with matter in it, in a degree excite the symptoms of the stone, and force the person to void the urine. Sometimes much matter from the kidneys will excite vehement symptoms; and this being found in the urine, and the pain being observed in the bladder only, the kidneys having little sense of pain, it is usually accounted for from ulcers in the bladder, which I have never found one instance of in all the numbers that I have opened in this case. Indeed the bladder is sometimes ulcerated, but that destroying part of the inner coat, the others stretch and ulcerate till the urine bursts through into the cellular membrane of the peritonæum, and cause a most miserable death. This case is very rare in men, and much more so in women. I have seen cancerous ulcers open the bladder into the uterus, but these, I think, have begun in the uterus. All these cases have symptoms like the stone; and not these only, but all diseases of the uterus which disturb the bladder, and even imposthumations or tumors that press upon the bladder, all give the same symptoms with the stone; except that of a needless disposition to stool at the time of making water. Some anatomists, not thinking how

soon fluids taken into the stomach, and not retained there by being mixed with solids, may pass into the blood, as the effects from drinking strong liquors or laudanum, or drinking without eating when we are hot, sufficiently shew; and also not considering the shortness of the course from the stomach to the kidneys this way, together with the size of the emulgent arteries, and the velocity of the blood in them have imagined and affirmed, that there must be some more immediate course from the stomach or guts to the bladder; and not considering either how such a course would have interrupted one great end in the animal economy, or that vessels fit to fill the bladder faster than the ureters, must have been too large to be concealed; nor, which proves it beyond contradiction, that the bladder is empty when the kidneys cease to do their office; which is frequently taken for a suppression of urine in the bladder. If in this last case, upon making a pressure on the region of the bladder, the patient does not feel great pain, it is scarce worth while to pass a catheter to search for urine. In suppressions of urine, whether merely inflammatory, or from the gout, or from an inflamed stricture in the urethra, I have found nothing so effectual as bleeding and purging. In a sanguine large man, where the penis was too much inflamed to suffer the catheter to pass, I took away three times twenty-four ounces of blood, and gave a purging clyster, and two strong purges, all within the space of twenty hours, which saved

the patient, and delivered him from excessive torment. Such practice may seem very severe, but in this case no time is to be lost; if the urine can be drawn off, the method of cure is still the same, but to be practised in a gentler manner.

Glandulæ renales are two glands seated immediately above the kidneys, of no certain figure, nor do we know their use; but always paint and describe them with the urinary parts, because of their situation: in a very young fœtus they are larger than the kidneys, and in an adult but a little larger than in a fœtus. They receive a great many small arteries, and return each of them one or two veins. In their inside is a small sinus, tinctured with a sooty-coloured liquor.

The testes are seated in the scrotum; their office is to separate the seed from the blood; they are said to have four coats, two common, and two proper. The common are the outer skin and a loose membrane immediately underneath, called dartos. The first of the proper is the processus vaginalis; it is continued from the peritonæum to the testicle, which it encloses with all its vessels, but is divided by a septum, or an adhesion immediately above the testicle, so that no liquor can pass out of that part of this membrane, which encloses the spermatic vessels, into that which encloses the testicle. Large quantities of water are sometimes found in either or both of these cavities, which disease is easily remedied by a puncture with a lancet; but

rarely cured without opening the cavity where the water is contained, as in sinuous ulcers. This I have done, and seen done several times, but never thought the cure worth the trouble and pain the patient underwent. The true hernia aquosa is from the abdomen, which either extends the peritonæum into the scrotum, or breaks it, and then forms a new membrane which thickens as it extends, as in aneurisms and atheromatous tumors. This may be decided by an injection, which will shew by the arteries that nourish it, whether it is a production from the peritonæum, or a new membranous bag formed in the scrotum: however, the dropsy in this cist, for such it properly is, rarely admits of more than a palliative cure by puncture or tapping, like the dropsy of the abdomen, and this with some difficulty, because the omentum usually, and sometimes the gut, descends with it. The other proper coat is the albuginea, which is very strong, immediately enclosing the testicles. The testicles of a rat may be unravelled into distinct vessels; and the texture of the testicles of other animals appear to be the same, but their vessels are too tender, or cohere too much to be so separated. The testicles receive each one artery from the aorta, a little below the emulgents, which, unlike all other arteries, arise small, and dilate in their progress, that the velocity of the blood may be sufficiently abated for the secretion of so viscid a fluid as the seed. The right testicle returns its vein into the cava, and the

left into the emulgent vein on the same side, both because it is the readiest course, and because, as authors say, this spermatic vein would have been obstructed by the pulse of the aorta, if it had crossed that vessel to go to the cava.

A gentleman, whom I castrated many years since, who trusted too much to his own resolution, and refusing to have any one present to hold him, except my assistant, during the operation, moved so much, that the ligature which tied all the vessels with the process together, slipt, and only tied the process over the ends of the vessels: which being perceived soon after the operation, I cut the ligature, and took out the extravasated blood, and tied the artery alone, which gave but little pain, and it digested off in a week's time, and the wound being afterwards stitched, though the testicle weighed a pound, it was perfectly well in five weeks; which is in less time than the ligature sometimes requires to be digested off, when the process and all the vessels are tied together. However, if this case is not sufficient to recommend doing this operation by tying the artery only, it may be sufficient to recommend extraordinary care in doing of it the usual way: for if the blood had found an easy passage into the abdomen, the patient might have bled to death.

On the upper part of the testicles, are hard bodies called epididymi; which are evidently the beginning of the vasa deferentia. I have un-

ravelled them backward, in single vessels, and then into more and smaller, like the excretory vessels of other glands.

Vasa deferentia are excretory ducts to carry the elaborated seed into the vesiculæ seminales. They pass from the epididymi of the testicles, together with the blood vessels, till they have entered the muscles of the abdomen, and then they pass under the peritonæum, directly through the pelvis, to the vesiculæ seminales.

Vesiculæ seminales are two bodies that appear like vesicles ; they are seated under the bladder of urine, near its neck ; they may be each of them unfolded into one single duct, which discharges into the urethra, by the sides of the rostrum gallinaginis, which is an eminence in the under side of the urethra near the neck of the bladder. In these vesicles, or ducts, the seed is reposited against the time of coition ; but in dogs there are no such vesicles, therefore nature has contrived a large bulb in their penis, which keeps them coupled, seemingly against their inclinations till the seed can arrive from the testicles. The seed passes from these vesicles in men, and even from the vasa deferentia, in time of coition, through the prostate glands into the urethra, as in those animals that have no vesiculæ seminales ; for when the ducts into the urethra are distended, that is the direct course from the vasa deferentia, as well as from the vesiculæ seminales.

Prostatæ are two glands, or rather one, about the size of a nutmeg: they lie between the vesiculæ seminales and penis, under the ossa pubis, almost within the pelvis of the abdomen. They separate a limpid glutinous humour which is carried into the urethra by several ducts, which enter near those of the prostatæ. This liquor seems to be designed to be mixed with the seed in the urethra, in the time of coition, to make it flow more easily. If the venereal infection reaches the prostate glands, it will sometimes make large abscesses, which are apt to form sinuses, and even make a passage into the bladder. Upon the first attack of this disease, I have prevented all this mischief, by taking off the external skin by incision, as far as the hardness of the tumour extended, which draining very plentifully, the tumour has subsided, and the patient been easily cured; but this case once becoming fistulous, is very difficult indeed. It often is cured by opening the sinuses and consuming the diseased parts by escarotics: but a much better and easier way, which I have often done, is to cut out all the fistulous and diseased parts at once.

Penis; its shape, situation, and use, need no description. It begins with two bodies named crura, from the ossa ischia, which unite under the ossa pubis, and are there strongly connected by a ligament. In its under part is the urethra, through which both the seed and urine pass; its

fore part is called glans, the loose skin which covers it præputium, and the straight part of that skin on the under side, frænum. The urethra is lined with a membrane filled with small glands that separate a mucus, that defends it against the acrimony of the urine. These glands are largest nearest the bladder. Mr. COWPER describes three large glands of the urethra, which he discovered; two of which are seated on the sides of the urethra near the ends of the crura penis; to which he adds a third, less than the other, seated almost in the urethra, a little nearer the glans than the former. All these glands have excretory ducts into the urethra, and from them are secreted all the matter which flows from the urethra in a gonorrhœa, whether venereal or not. In the venereal infection, the urethra and the glands are first inflamed by the contagious matter, that causes a heat of urine, which abates as soon as the glands begin to discharge freely; but if by chance this disease continues till any part of the urethra is ulcerated; the ulcer never heals without a cicatrix, which constricts the urethra, and makes that disease which is vulgarly called a caruncle. The inner texture of the penis is spongy, like the inner texture of the spleen, or the ends of the great bones. It is usually distinguished into corpus cavernosum penis, glandis, and urethræ. The first of these makes part of the glans, and is divided its whole length by a septum; the other two are composed

of smaller cells, and are but one body. On the upper side of the penis are two arteries, and one vein called vena ipsius penis. The arteries are derived from the beginnings of the umbilical arteries, which parts never dry up, and the vein runs back to the iliac veins. The vena ipsius penis, being obstructed, the blood that comes by the arteries, distends the cells of the whole penis, and makes it erect; but to prevent mischief from this mechanism, there are small collateral veins on the surface of the penis, that carry back some blood all the time the penis is erect; but by what power the vena ipsius penis is obstructed to erect the penis, I cannot conceive, unless small muscular fibres constrict it. Some think the musculi erectores penis do it, by thrusting the penis against the os pubis; but they seem not seated conveniently for such an office; besides, if a pressure from the lower side of the penis is sufficient, an artificial pressure, which may be much greater, should, I think, produce the same effect.

In the seed of men, and of other male animals, LEWENHOECK, by the help of microscopes, discovered an infinite number of animals like tadpoles, which he and others suppose to be men in miniature, and that one of these being entered into an egg in one of the ovaria (see the next chapter) conception is performed. But though scarce any one, that has made due inquiry, has ever doubted of the existence of these animals,

yet there are many who object against this hypothesis; and though I am inclined to think it true, yet I will endeavour impartially to lay down the principal objections and answers, that the reader may judge for himself. The first and strongest objection, is raised from the several instances that have happened of mixed generation, where the animal produced always appears to partake of both kinds, as in the common case of a mule, which is begot by an ass upon a mare; when, according to that hypothesis, they expect the animal produced from mixed generation should be entirely of the same species with the male animal; as the seeds of plants, whatever earth they grow in, always produce plants of the same kind. Nevertheless, if we consider what influence women's fears or longings frequently have upon their children in utero, and how great a change castration makes in the shape of any animal, we cannot then wonder if the mother's blood, to which the animal owes its nourishment and increase, from the time of impregnation to the time of its birth, should be thought a sufficient cause of resemblance between these animals and their mothers. Another objection is, that nature should provide such a multiplicity of these animals, when so few can ever be of use. To which it has been answered, that in plants a very few of the whole that are produced, fall into the earth, and produce plants; and as in plants the greatest part of their seeds

are the food of animals, so the greatest part of the animalculæ may as well live a time to enjoy their own existence, as any other animal of as low an order. The last objection is their shape, which I think will appear to have no great weight, when we consider how the eggs of flies produce maggots, which grow up into flies; and the tadpole produced from the egg of a frog, grows into a form as different from a tadpole as the form of a man: and if these animals had produced so few at a time, as that their young might have undergone this change in utero, it is highly probable, that we should not so much as have suspected these analogous changes. But how the animalculæ themselves are produced, is a difficult question, unless by equivocal generation, seeing none of them appear to be in a state of increase, but all of a size.

In a boy that died of the stone, I found a double ureter, each part being dilated to an inch diameter; the pelvis in each kidney to twice its natural bigness, and the tubuli urinarii, each as large as the pelvis.

In a man that had never been cut for the stone, I found the ureters dilated in some places to four inches circumference, and in others but little dilated, and a stone that I found in the bladder was less than a nutmeg, which must have fallen in several pieces, or both ureters could not have been dilated. From this, and other like observations,

I think it appears, that the great size to which the ureters are usually extended, in people who are troubled with the stone, is owing to small stones which stick at the entrance into the bladder, until the obstructed urine, which dilates the ureters, can force them into the bladder.

I have in several subjects found one kidney almost consumed, and once a man with but one kidney; and I have seen lymphatics in a diseased testicle, as large as a crow quill.

CHAPTER II.

OF THE GENITAL PARTS OF WOMEN.

THE external parts are the mons veneris, which is that rising of fat covered with hair above the rima magna upon the os pubis, the great doubling of the skin on each side the rima called labia, and within these a lesser doubling named nymphæ. These help to close up the orifice of the vagina. The nymphæ are usually said to serve to defend the labia from the urine; but I do not see how the labia stand more in need of such a defence, than the nymphæ themselves.

Clitoris is a small spongy body, bearing some analogy to the penis in men, but has no urethra. It begins with two crura from the ossa ischia, which uniting under the ossa pubis, it

proceeds to the upper part of the nymphæ, where it ends under a small doubling of skin, called præputium; and the end which is thus covered is called glans. This is said to be the chief seat of pleasure in coition, in women, as the glans is in men.

A little lower than this, just within the vagina, is the exit of the meatus urinarius.

Vagina is seated between the bladder of urine and the intestinum rectum. The texture of it is membranous, and its orifice is contracted with a sphincter (vid. musc. sphincter vaginæ) but the farther part is capacious enough to contain the penis without dilating. Near the beginning of the vagina, immediately behind the orifice of the meatus urinarius, is constantly found in children a valve called hymen, which, looking towards the orifice of the vagina, closes it; but as children grow up, and the sphincter vaginæ grows strong enough to contract and close the orifice of the vagina, this valve becoming useless, ceases to increase, and is then known by the name of carunculæ myrtiformes. There have been a few instances in which the edges of this growing together, it continued unperforate, until it has been necessary to make an incision to let out the menses. The inner part of the vagina is formed into rugæ, which are largest in those who have not used copulation; and least in those who have had many children. Under these rugæ are small glands,

whose excretory ducts are called lacunæ: these glands separate a mucilaginous matter to lubricate the vagina, especially in coition: and are the seat of a gonorrhœa in this sex, as the glands in the urethra are in the male.

Uterus is seated at the end of the vagina; it is about one inch thick, two broad, and large enough to contain the kernel of a hazel nut; but in women that have had children, a little larger. Its orifice into the vagina is called os tincæ, from the resemblance it bears to a tench's mouth. It has two round ligaments which go from the sides of it to the groins through the oblique and transverse muscles of the abdomen, in the same manner as do the seminal vessels in men. This way the gut passes in a hernia intestinalis in women (vid. musculi abdominis.) Some authors mention ligamenta lata, which are nothing but a part of the peritonæum. Near the sides of the uterus lie two bodies called ovaria; they are of a depressed oval figure, about half the size of men's testicles, and have spermatic vessels; they contain small pellucid eggs, from which they have their name. There are two arteries and two veins, which pass to and from the ovaries or testes, in the same manner that they do in men; but make more windings, and the arteries dilate more suddenly, in proportion as they are shorter. These arteries and veins detach branches into the uterus and fallopian tubes, and not only make communications

betwixt the artery and vein on one side and those of the other, but also with the proper vessels of the uterus, which are detached from the internal iliac arteries and veins. From these vessels in the inside of the uterus, the menstrual purgations are made in women, and something of the same kind in brutes, as often as they desire coition. One use of these purgations is, to open the vessels of the uterus, for the vessels of the placenta to join to them. Many authors have imagined, that there must be some evacuations analogous to this, in men, which I cannot see the necessity of; but, on the contrary, I believe that men's not having such evacuations, is the true reason why their bodies grow larger and stronger than women's: and their continuing to grow longer before they are fit for marriage, I also take to be the true reason why there are more males born than females, in about the proportion of thirteen to twelve; for women being sooner fit for marriage than men, fewer will die before that time, than of men.

Near the sides of the ovaria are seated the tubæ fallopianæ, one end of which is connected to the uterus and the side of the ovarium by a membrane, the other end is loose, and being jagged is called morsus diaboli. Among these jags is a small orifice which leads into the tube, which near this end is about a quarter of an inch diameter, and thence, growing gradually smaller, passes to the uterus, and enters there with an orifice

about the size of a hog's bristle. The use of these tubes is to convey the male seed from the uterus to the ovaria, to impregnate the eggs for conceptions; yet they appear so ill adapted to this end, that many have supposed there must be some other passage from the uterus to the ovaria: but when we consider the case of conceptions found in these tubes, and the exact analogy between these and the tubes of birds, where we have the most undeniable proofs of the seed going through the tube, and of the eggs being impregnated that way, and of the eggs coming from the ovarium through the tube, and seemingly with much greater difficulty than in women; and besides, how frequently a matter like the male seed (which I suppose is seed) is found in the fallopian tubes of women, as I have found in executed bodies, and in a common whore that died suddenly, it appears to me almost certain, that the seed goes through the fallopian tubes to the ovaria to impregnate eggs, and comes back through the same tubes to the uterus. I have seen in a woman both the fallopian tubes unperforated, which, upon the foregoing hypothesis, must have caused barrenness, and seed lodged in these tubes may have the same effect; which I take to be often the case of common whores, and women that use coition too frequently; and perhaps the fat in the membrane that connects the ovaria to the tubes, may in very fat women so keep these tubes from the ovaria as

to interrupt impregnations; and besides these cases, too much or too little of the menses may destroy or interrupt conceptions; but the latter case, especially in young women, is very rare. From such causes as these, and not from imbecility, I imagine it is that barrenness oftener proceeds from women than men; and though women do not propagate to so great an age as men, it is not, I believe, for want of being impregnated, but from their menses ceasing, and those vessels being closed which should nourish the fœtus after the impregnation, as if on purpose to prevent the propagation of a feeble and infirm species. And from this consideration, one cannot but think that the perfection of the fœtus, notwithstanding it is first formed in the male seed, depends more upon the female than the male; or else that nature would, for the sake of the species, have been careful to hinder men as well as women from propagating in a declining age.

CHAPTER III.

OF THE FOETUS IN UTERO.

THE fœtus in utero is involved in two coats, viz. chorion, which is external, and amnion, which immediately encloses the fœtus. They contain a quantity of liquor, which is a proper medium for so tender a being as the fœtus to rest in, and partly secures it from external injuries, as the aqueous humour does the crystalline in the eye; and when the membranes burst at the time of production, this humour lubricates the vagina uteri, to render the birth less difficult. And seeing the stomach of a fœtus in utero is always full of a fluid, like what is contained in the amnion, and the guts not without excrements; we may suppose that this fluid is frequently, during the time of gestation, swallowed by the fœtus, if not for nourishment, at least to keep these parts in use, and to flow through the lacteals, as a quantity of blood from the right ventricle of the heart flows through the lungs before the birth to keep open those passages till the birth, there being after that time no other way of receiving nourishment, and that the fæces found in the guts of a fœtus are those parts of this fluid that were taken in at the mouth, and were too gross to enter the lacteals. Yet I own it takes off very much from the probability of the opinion of the fœtus's imbibing this

liquor, that, if I am rightly informed, some who have been born with mouths and nostrils unperforate, have had such fluids and excrements in the intestines that other fœtus's have, which must be confessed, may be derived from the salivary glands and from the liver, &c. The following curious passage was sent me by Mr. MONRO. "This li-
" quor contributes nothing to the nourishment of
" the fœtus, for these reasons; first, because, as
" you have well observed, vast numbers of in-
" stances might be produced, where no passage
" was to be found for it: I shall give you one I
" saw myself in the Hotel de Dieu at Paris, in
" 1718.

" MARY GUERLIN brought forth two children,
" one a complete girl, the other had neither head,
" neck, arms, heart, lungs, stomach, small guts,
" liver, spleen, or pancreas, yet the great guts,
" the organs of urine and generation of a female,
" and lower extremities were perfect, and of a na-
" tural growth; the umbilical vein, after entering
" the abdomen, split into a great many branches,
" which were distributed to the several parts in
" its abdomen. Though it is true that soon af-
" ter conception, the liquor in the amnion, and
" that in the stomach of the fœtus resemble one
" another pretty near, yet afterward they differ
" exceedingly; for the liquor in the stomach is
" still gelatinous, thick, and without acrimony,
" while the other becomes thinner and more acrid;

"whereas, had the fœtus constantly swallowed "this liquor, the case would have been quite op- "posite; nay, often it has happened that these "waters (as they are commonly called) have been "found quite corrupted, strongly fetid, and ex- "tremely sharp, while the fœtus, except the in- "juries which the external parts received, was "well and sound; witness the example mentioned "by BELLINGER, of a woman who was cured of "a virulent gonorrhœa during her going with "child. And farther, by MALPIGHIUS's delinea- "tions of the pullus in ovo, it appears to be evi- "dent that the asitellus serves the same purpose as "the placenta does in viviparous animals, to con- "vey the albumen attenuated by incubation into "the blood vessels of the chick, and that none of "the albumen does pass through the saccus colli- "quamenti."

Besides these coats, in a cow and many other animals, we find a membrane called alantois; it is enclosed by the chorion together with the amnion, and contains a quantity of water which it receives from the bladder of urine by the urachus. Its use seems to be to contain the urine, that it might not by the common passage be emptied into the liquor of the amnion, of which the fœtus, I am inclined to think, is frequently drinking.

Whether an alantois is to be found with a human fœtus or no, anatomists are not agreed, and I cannot give my opinion, having never had a

sufficient opportunity to inquire. But surely children having an urachus, one cannot well doubt of an alantois. I have been informed by a gentleman, whose probity I can sufficiently rely on, that he had seen a child that had no external genital parts, and made water through the navel. At Henley upon Thames, there is now living a bargeman's child about ten years old, of which I had the like account; but upon examination I found the unperforated glans with its frænum immediately below the place of the navel, and the urine issued out by drops between this and the belly, in the place which I suppose was the navel, but it was so much excoriated, that I could make no certain judgment about it. In the uterus of a cow with two calves, I found they had but one chorion, but each an amnion and alantois distinct; but the cotyledons, which are analogous to the placenta of the human fœtus, were pretty much in common to the umbilical blood vessels of both.

The placenta, or womb-liver, is a mass of blood vessels seated on the outside of the chorion, being composed of the extreme branches of the umbilical vein and arteries, which are, for the composition of this part, divided into exceeding small branches, to join a like number of the menstrual vessels of the uterus; which vessels of the uterus are made numerous rather than large, that the separation of the placenta from them may not be attended with a flux of blood fatal to the mo-

ther; for the sides of little vessels soon collapse and close, and they are more easily stopped, being compressed by the uterus itself as it shrinks, which it begins to do from the time of the birth; but when the placenta is separated before the delivery, whether untimely or not, these vessels bleed until the uterus is discharged of the fœtus. The figure of the placenta is circular, and at its greatest growth about two inches thick, and six or seven in diameter.

The arteries and veins of the uterus of the mother, by which the menstrual purgations are made, are joined to the umbilical arteries and veins in the placenta of the fœtus, the arteries of the uterus to the veins in the placenta, and the veins in the uterus to the arteries of the placenta: by these vessels a large quantity of blood is continually flowing from the mother to the fœtus and back again; but for what end such a quantity flows continually, and back again, I cannot conceive, unless it is that the fœtus not breathing for itself, it is necessary that as much blood of the mother should flow continually to the fœtus, as can leave enough of air, or whatever our blood receives in the lungs, for the fœtus; and perhaps what nutritious juices the fœtus receives, require a great deal of blood to convey them, they being but a small part of the blood. And though the blood passes so plentifully between the mother and the fœtus, yet the communications are not so obvious as they

are between the arteries and veins in the same body; which makes some think the communication is not made by inosculations of vessels, but that the fœtus is nourished from the placenta in a vegetable manner; but, I own, I am not of this opinion. The navel string or umbilical blood vessels, between the placenta and the navel, are about two feet long, that the fœtus may have room to move without tearing the placenta from the uterus, which being done too soon, from whatever cause, occasions a miscarriage. These vessels, viz. two arteries and one vein, twist about each other, particularly the arteries about the vein, and are contained in one common coat together with a vessel called urachus, which arises from the top of the bladder of urine, and ends in the membrana alantois; the umbilical vein goes from the navel directly into the liver, and there enters the great trunk of the vena portæ. Near which entrance there goes out the ductus venosus to the great trunk of the cava, which carries part of the blood that is brought by the umbilical vein, that way into the cava, while the rest circulates with the blood in the porta, the whole of it not passing through the ductus venosus, as is generally believed, but a great part of it into branches of the porta, in the liver, otherwise there need be no communication between the umbilical vein and the porta. When the umbilical vein is stopped, it becomes a ligament, and the ductus venosus soon shrinks

and almost disappears, having no longer any blood flowing through it ; and even the porta itself within the liver, from whence only blood could pass after the birth into the ductus venosus, has less blood flowing through it for some time than it had before the birth, it receiving much blood before the birth from the umbilical vein. The blood which flows from the mother to the fœtus by the umbilical vein, is returned, all but a small quantity, which is reserved for nutrition by the two umbilical arteries, which arise from the internal iliac arteries, and passing by the outsides of the bladder go directly to the navel, and placenta ; these with the urachus being shrunk up after the birth, lose much of their appearance, especially near the navel, where they are sometimes not to be distinguished.

Part of the blood before the birth, and not the whole quantity, as is generally thought, which is brought by the ascending cava to the right auricle, passes at once through the foramen ovale into the left auricle, and the rest flows into the right ventricle with the blood of the descending cava, and thence into the pulmonary artery, where about one half flows into the lungs, and the other half directly into the aorta by the ductus arteriosus, which lies between the pulmonary artery and the aorta, which after the birth is called ductus arteriosus in ligamentum versus. The better to explain this contrivance, I will call the quantity of

blood flowing through the ascending cava in a given time, four; and that which flows through the descending cava, two: then let two of the quantity in the ascending cava flow into the right auricle, it will then with the two received from the descending cava have the quantity four; which being thrown from the right ventricle into the pulmonary artery, the quantity two is thrown into the aorta by the ductus arteriosus, and the same quantity into the lungs by the pulmonary branches; then the quantity returning from the lungs to the left auricle, will be two in the same given time, which being added to the two which flowed through the foramen ovale, in the same time there will be constantly the same proportions received into each ventricle, at every diastole of the ventricles, as after the birth. Now if the blood, flowing through the ascending cava joined by that from the umbilical vein, was but equal to that flowing through the descending, let each of them be called two, and let all the blood of the ascending cava go through the foramen ovale; then the blood which the left ventricle would receive, would exceed that which flows into the right, by the whole quantity which flows from the lungs in the same time; but the ascending cava conveying more blood than the descending cava, the excess in the left ventricle would be yet greater. If the proportions, which I have taken for the easier computing, were perfectly right, as I am sure

they are nearly, then the quantity flowing into the left ventricle would be to that flowing into the right at the same time as five to two, if all the ascending blood went through the foramen ovale.

And though after the birth the left ventricle of the heart is only employed in throwing blood into the aorta, and the right wholly employed in circulating the blood through the lungs; yet before the birth, all the blood thrown out by the left ventricle, and about half the blood thrown out of the right ventricle, being thrown into the aorta, and the other part only through the lungs, it follows, that the whole force exerted by the left ventricle, with about half that of the right, is employed in throwing blood into the aorta, while that distributes blood through the whole fœtus and to the mother: but after the birth, when the blood is to be no longer carried from the fœtus to the mother, the left ventricle becomes sufficient for the circulation through the fœtus, and a new occasion immediately arises for that additional power, which before was necessarily employed in throwing blood into the aorta: for the whole mass of blood now being to be circulated through the lungs, the ductus arteriosus closes, and the right ventricle must throw all the blood it receives into the lungs, there being no longer any passage into the aorta. It is supposed that the inflation of the lungs at the birth, presently alters the position of the ductus arteriosus, so as to obstruct it; which

account is indeed mechanical, but, I think, not true, because I can neither discern that the position of this vessel is altered, nor its surface compressed: but I rather think that immediately upon the birth, there being no blood carried off from the fœtus to the mother, and the left ventricle being sufficient to fill the aorta and its branches with blood, as I have shewn before, there is no longer room for any blood from the right ventricle; wherefore the blood from the right ventricle will be forced into the lungs, where the passage is now made easy, as I imagine, by their being inflated; and the ductus arteriosus, having the blood no longer forced into it, shrinks, and in time almost disappears. This duct being stopped, the valve of the foramen ovale soon stops that passage, it being on the side of the left auricle (or that muscular bag, which is the largest part of that auricle) which being much the strongest, the valve must be pressed more on that side than the other, by the blood, in the time of the systole of the auricle; and it is as evident, that in the diastole of the auricle, there must be more pressure to open that than the right, it being a stronger muscle, or else there could have been no reason for having the left auricle stronger than the right, in proportion to their ventricles. Sometimes this valve does not quite cover the foramen, in which case a small quantity of the blood may possibly flow from the left auricle to the right, and so circulate twice

through the lungs to once through the body, but none could flow from the right to the left and escape the lungs, which might be of bad consequence. Some have imagined, that men, who have this passage open, cannot be drowned: but though this passage is sometimes found open, no man has been yet seen, that we have ever heard of, that could not be drowned. I have seen the foramen open in a man that was hanged, to whom one might justly expect it should have been as useful as in the case of submersion in water. Many writers have supposed, that this foramen is open in amphibious animals, and in such fishes as have two auricles, two ventricles, and lungs like land animals, without gills, which in other fish are analogous to lungs. I have dissected a porpoise, which is of this kind, and found this foramen closed, but the great veins were vastly large in proportion to the bulk of the animal; whence I conjectured, their blood was accumulated in their veins, while they kept under water, and by that means the lungs escaped being oppressed with blood; which conjecture seemed to me the more probable, since all animals of this kind are able to abide the least time under water, when their blood is most expanded with heat. But upon the dissection of an otter, whose foramen ovale was also closed, I found the veins nothing differing from those of other animals. In a water tortoise, which I had an opportunity of examining, with that

most dexterous and indefatigable anatomist, Dr. Douglas, I found the two ventricles of the heart but half divided by a septum, and in the beginning of the pulmonary artery several strong muscular rings, a little distance from each other, each of which, by contracting, would be capable of resisting a part of that blood which otherwise would have been thrown into the lungs, when they were under water; and this blood so obstructed must necessarily be thrown into the aorta, the two ventricles being in a manner one common cavity; and when they are out of the water, this communication of ventricles, will suffer but little confusion of the blood which flows into the ventricles, because each ventricle receiving and discharging the same quantity of blood, at the same time, they will balance each other, and thereby such a mixture will be very much prevented. Mr. Monro observes, that the water tortoise has very large lungs, consisting of larger vesicles than land animals, and that they receive a great quantity of air to furnish that je ne sçai quoi so necessary for the life of animals; the same thing I have observed in frogs.

As to the reason of women's bringing forth at the usual time; it has been said, that at that time the head of the child begins to be specifically heavier than the rest of the body, and therefore must fall lowest in the fluid it lies in, which being an uneasy posture, makes the child struggle, and

bring on the labour. But it is not true, that the head then alters its specific gravity; or, if it did, there is seldom fluid enough in the amnion for this purpose; and besides, this could only happen right in one posture, and would usually happen wrong in brutes.

CHAPTER IV.

OF THE EYE.

THE figure, situation, and use of the eyes, together with the eyebrows, eyelashes, and eyelids, being well known, I need only describe what is usually shewn by dissecting. The orbit of the eye, or cavity in which it is contained, is in all the vacant places filled with a loose fat, which is a proper medium for the eye to rest in, and serves as a socket for it to be moved in. In the upper and outer part of the orbit, is seated the lacrymal gland. Its use is to furnish at all times water enough to wash off dust, and to keep the outer surface of the eye moist, without which the tunica cornea would be less pellucid, and the rays of light would be disturbed in their passage; and that this liquor may be rightly disposed of, we frequently close the eyelids to spread it equally, even when we are not conscious of doing it. At the inner corner of the eye, between the eyelids,

stands a caruncle, which seems to be placed to keep that corner of the eyelids from being totally closed, that any tears or gummy matter may flow from under the eyelids, when we sleep, or into the puncta lacrymalia, which are little holes, one in each eyelid, near this corner, to carry off into the ductus ad nasum any superfluous tears.

The first membrane of the eye is called conjunctiva; it covers so much of the eye as is called the white, and being reflected all round, it lines the two eyelids; it being thus returned from the eye to the inside of the eyelids, it effectually hinders any extraneous bodies from getting behind the eye into the orbit, and smooths the parts it covers, which makes the friction less between the eye and the eyelids. This coat is very full of blood vessels, as appears upon any inflammation.

Tunica sclerotis, and cornea, make together one firm case of a proper form, for the use of the other coats and humours. The fore part of this strong coat being transparent, and like horn, is called cornea, and the rest sclerotis. Under the cornea lies the iris, which is an opaque membrane, like the tunica choroides, but of different colours in different eyes, such as the eye appears, as grey, black, or hazel; for being seated under the tunica cornea, it gives such an appearance to that as it has itself. The middle of it is perforated for the admission of the rays of light, and is called the pupil. Immediately under

the iris lie the processus ciliares, like radial lines from a lesser circle to a greater. When these processes contract, they dilate the pupil to suffer more rays of light to enter into the eye; and the contrary is done by the circular fibres of the iris, which act as a sphincter muscle: but these changes are not made with great quickness, as appears from the eyes being oppressed with a strong light for some time, after we come out of a dark place, and from the contrary effect in going suddenly from a light place to a dark one. And as the pupil always dilates in darker places, to receive more rays of light, so when any disease makes some of those rays ineffectual, which pass through the pupil, it dilates as in dark places to admit more light; therefore a dilated pupil is a certain sign of a bad eye, and this may be discerned usually sooner than the patient discerns any defect in vision. In men the pupil is round, which fits them to see every way alike: it is also round in animals that are the prey both of birds and beasts. But graminivorous brutes, that are too large to be the prey of birds, have it oblong horizontally, which fits them to view a large space upon the earth; while animals of the cat kind, who climb trees and prey indifferently on birds or animals that hide in the earth, have their pupils oblong the contrary way, which fits them best to look upward and downward at once. Besides these there are other animals whose pupils are in these forms, but in less

proportions, so as best to fit their ways of life. Immediately under the sclerotis, is a membrane of little firmness, called choroides. In men it is of a rusty dark colour, such as will bury almost all the rays of light, that pass through the tunica retina, which if it were of a brighter colour, would reflect many of the rays upon the retina, and make a second image upon the first somewhat less, and less distinct, but both together stronger; which is the case of brutes of prey, where a great part of this coat is perfectly white, which makes them see bodies of all colours in the night better than men, for white reflects all colours: but brutes that feed only on grass, have the same parts of this membrane of a bright green, which enables them also to see with less light, and makes grass an object that they can discern with greatest strength. But these advantages in brutes necessarily destroy great accuracy in vision, which is of little or no use to them, but to men of great consequence. This green part of the tunica choroides in animals that graze, may properly be called membrana uvea, from its resemblance in colour to an unripe grape. But in men's eyes only a white circle round the back side of the choroides near the cornea, is called uvea.

Immediately under the tunica choroides lies the tunica retina, which is the optic nerve expanded and coextended with the choroides. Rays of light striking upon this membrane, the

sensation is conveyed by the optic nerves, to the common sensorium the brain. These nerves do not enter at the middle of the bottom of the eyes, but nearer the nose; for those rays of light being ineffectual for vision that fall upon the entrance of the optic nerves, it is fit they should so enter, as that the same object or part of any object should not be unperceived in both eyes, as would have been the case, had they been otherwise inserted; which appears from a common experiment of part of an object being lost to one eye, when we are looking towards it with the other shut. I know a gentleman, who having lost one eye by the small-pox, and going through a hedge, a thorn unseen (probably from this cause) struck the other and put it out. The two optic nerves, soon after they arise out of the brain, join, and seem perfectly united; yet from the following case I am not without suspicion of their fibres being preserved distinct, and that the nerve of each eye arises wholly from the opposite side of the brain, or else that the other nerves throughout the body arise from the brain, and medulla oblongata, on the sides opposite to those they come out of. A soldier, who was my patient in the hospital about five years since, had, by a push with a broad sword, his left eye raised in the orbit, which I replaced with my fingers; it was presently followed with excessive pain in the right side of the head only; and a loss of the sense of feeling and

motion in both the right limbs; the sense of feeling he recovered by degrees in about a month, and soon after began to recover their motion, but was twelve months before he could walk, and lift up his hand to his head; and in about two years recovered all but the sight of the wounded eye, which indeed did not appear perfect. In fish these nerves arise distinct from the opposite sides of the brain, and cross without uniting; but as these animals have their eyes so placed, as not to see the same object with both eyes at once, whereas animals, whose optic nerves seem to unite, do see the same object with both eyes at once, one would suspect that in one they were joined to make the object not appear double, and in the other distinct, to make their two eyes (as they are to view different objects at the same time) independent on each other: and yet from the following cases, the seeing objects single seems not to depend upon any such union, nor from the light striking upon corresponding fibres of the nerves, as others have believed, but upon a judgment from experience, all objects appearing single to both eyes in the manner we are most used to observe them, but in other cases double; for though we have a distinct image from each eye sent to the brain, yet while both these images are of an object seen in one and the same place, we conceive of them as one; so when one image appears to the eyes (when they are distorted or wrong di-

rected) in two different places, it gives the idea of two; and when two bodies are seen in one place, as two candles rightly placed, through one hole in a board, they appear one. But cases of this kind being too numerous, I will conclude with one very remarkable, and, I think, much in favour of this opinion. A gentleman, who from a blow on the head had one eye distorted, found every object appear double, but by degrees, the most familiar ones became single, and in time, all objects became so, without any amendment of the distortion.

The inside of the eye is filled with three humours, called aqueous, crystalline, and vitreous. The aqueous lies foremost, and seems chiefly of use to prevent the crystalline from being easily bruised by rubbing, or a blow; and perhaps it serves for the crystalline humour to move forward in, while we view near objects, and backward for remoter objects; without which mechanism, or, in the place of it, a greater convexity in the crystalline humour in the former case, and a less convexity in the latter, I do not imagine, according to the laws of optics, how we could so distinctly see objects at different distances. However it is in land animals, I think we may plainly see that fish move their crystalline humour nearer the bottom of the eye when they are out of water, and the contrary way in water; because light is less refracted from water through the crystalline hu-

mour than from air. Some have said, that amphibious animals have a membrane like the membrana nictitans of birds, which serves them as a lens in the water. I have examined the eye of a crocodile, which Sir HANS SLOAN kept in spirits, and I found this membrane equally thick and dense, and consequently unfit for this purpose, or, I believe, any other, except that obvious one, of defending the eye from the water. Next behind the aqueous humour lies the crystalline; its shape is a depressed spheroid, it is distinctly contained in a very fine membrane called aranea. The use of this humour is to refract the rays of light which pass through it, so that each pencil of rays from the same point of any object may be united upon the retina, as in a camera obscura, to make the stronger impression: and though by this union of the rays a picture inverted is made upon the retina, yet surely it is the impulse only of the rays upon the retina that is the cause of vision; for had the colour of the retina been black, and consequently unfit to receive such a picture, would not the impulse of light upon it have been sufficient for vision? or would such a picture, if it could have been made without any impulse, have ever conveyed any sensation to the brain? Then if the impulse of light upon the retina, and not the image upon the retina, is the cause of vision; when we inquire why an image inverted in the eye appears otherwise to the mind, might

we not expect to find the true cause from considering the directions in which the rays strike the retina, as we judge of above and below from a like experience, when any thing strikes upon any part of our bodies? Nevertheless, in viewing an object through a lens, we conceive of it as inverted; when as in receiving the impulses of light in the same manner, and having the picture on the retina in the same attitude, when we stand on our heads without the lens, we have not the same, but the contrary idea of the position of the object. Though I have considered this humour only as a refractor of light, yet the first and greatest refraction is undoubtedly made in the cornea; but it being concavo-convex, like glasses of that kind, while one side makes the rays of light converge, the other diverges them again. The same thing also may be observed of the aqueous humour, which is indeed more concave than convex; but when the crystalline humour is removed in the couching a cataract, the aqueous possesses its place and becomes a lens; but that refracting light less than the crystalline, whose place and shape it partly takes, the patient needs a convex glass to see accurately. In some eyes, either this humour being too convex or too distant from the retina, the rays unite too soon, unless the object is held very near to the eye, which fault is remediable by a concave glass; as the contrary fault, common to old persons, is by a convex glass. If the eye

had been formed for a nearer view, the object would often obstruct the light; if it had been much farther, light enough would not commonly have been produced from the object to the eye. In fish the crystalline humour seems a perfect sphere, which is necessary for them, because light being less refracted from water through the crystalline humour than from air, that defect is compensated by a more convex lens. The vitreous humour lies behind the crystalline, and fills up the greatest part of the eye: its fore side is concave for the crystalline humour to lodge in, and its back side being convex, the tunica retina is spread over it; it serves as a medium to keep the crystalline humour and the retina at a due distance.

The larger animals having larger eyes, their organs of vision, like a microscope with a large lens, are fit to take in a greater view, but in that view things are not so much magnified; in lesser animals a small space is discerned, such as is their sphere of action, but that greatly magnified, not really so in either case, but comparatively, for vision shews not the real magnitude of objects, but their proportions one to another. Fish have their eyes, and particularly their pupils, larger than land animals, because there is less light, and that not so far distributed in water as in the air. In all inflammations in the eye, the utmost haste should be made, by bleeding, purging, abstinence, &c. to get rid of the inflammation, because a con-

tinued inflammation seldom fails to make white opaque scars in the cornea, which cause dimness if not blindness; and no eye water with powders in it should ever be put upon the eye, because none can be made fine enough.

An account of observations made by a young gentleman who was born blind, or lost his sight so early that he had no remembrance of ever having seen, and was couched between thirteen and fourteen years of age.

THOUGH we say of this gentleman that he was blind, as we do of all people who have ripe cataracts, yet they are never so blind from that cause but that they can discern day from night, and for the most part, in a strong light, distinguish black, white, and scarlet; but they cannot perceive the shape of any thing; for the light, by which these perceptions are made, being let in obliquely through the aqueous humour, or the anterior surface of the crystalline, by which the rays cannot be brought into a focus upon the retina, they can discern in no other manner, than a sound eye can through a glass of broken jelly, where a great variety of surfaces so differently refract the light, that the several distinct pencils of rays cannot be collected by the eye into their proper foci; wherefore the shape of an object in such a case cannot be at all discerned, though the colour may;

And thus it was with this young gentleman, who, though he knew these colours asunder in a good light, yet when he saw them after he was couched, the faint ideas he had of them before, were not sufficient for him to know them by afterwards, and therefore he did not think them the same which he had before known by those names. Now scarlet he thought the most beautiful of all colours, and of others the most gay were the most pleasing; whereas the first time he saw black it gave him great uneasiness, yet after a little time he was reconciled to it; but some months after, seeing by accident a negro woman, he was struck with great horror at the sight.

When he first saw, he was so far from making any judgment about distances, that he thought all objects whatever touched his eyes (as he expressed it) as what he felt did his skin, and thought no object so agreeable as those which were smooth and regular, though he could form no judgment of their shape, or guess what it was in any object that was pleasing to him: he knew not the shape of any thing, nor any one thing from another, however different in shape or magnitude: but upon being told what things were, whose form he before knew from feeling, he would carefully observe, that he might know them again; but having too many objects to learn at once, he forgot many of them; and (as he said) at first he learned to know, and again forgot a thousand

things in a day. One particular only, though it may appear trifling, I will relate: Having often forgot which was the cat, and which the dog, he was ashamed to ask; but catching the cat, which he knew by feeling, he was observed to look at her steadfastly, and then, setting her down, said, So, puss, I shall know you another time. He was very much surprised, that those things which he had liked best, did not appear most agreeable to his eyes, expecting those persons would appear most beautiful that he loved most, and such things to be most agreeable to his sight that were so to his taste. We thought he soon knew what pictures represented, which were shewed to him, but we found afterwards we were mistaken; for about two months after he was couched, he discovered at once they represented solid bodies, when to that time he considered them only as party coloured planes, or surfaces diversified with variety of paint; but even then he was no less surprised, expecting the pictures would feel like the things they represented, and was amazed when he found those parts, which by their light and shadow appeared now round and uneven, felt only flat like the rest, and asked which was the lying sense, feeling, or seeing?

Being shewn his father's picture in a locket at his mother's watch, and told what it was, he acknowledged a likeness, but was vastly surprised; asking how it could be, that a large face could

be expressed in so little room; saying, it should have seemed as impossible to him, as to put a bushel of any thing into a pint.

At first, he could bear but very little light, and the things he saw he thought extremely large; but upon seeing things larger, those first seen he conceived less, never being able to imagine any lines beyond the bounds he saw; the room he was in, he said, he knew to be but part of the house, yet he could not conceive that the whole house could look bigger. Before he was couched, he expected little advantage from seeing, worth undergoing an operation for, except reading and writing; for he said, he thought he could have no more pleasure in walking abroad than he had in the garden, which he could do safely and readily. And even blindness, he observed, had this advantage, that he could go any where in the dark, much better than those who can see; and after he had seen, he did not soon lose this quality, nor desire a light to go about the house in the night. He said, every new object was a new delight; and the pleasure was so great, that he wanted words to express it; but his gratitude to his operator he could not conceal, never seeing him for some time without tears of joy in his eyes, and other marks of affection: and if he did not happen to come at any time when he was expected, he would be so grieved, that he could not forbear crying at his disappointment. A year after first seeing, being

carried upon Epsom Downs, and observing a large prospect, he was exceedingly delighted with it, and called it a new kind of seeing. And now being lately couched of his other eye, he says, that objects at first appeared large to this eye, but not so large as they did at first to the other; and looking upon the same object with both eyes, he thought it looked about twice as large as with the first couched eye only, but not double, that we can any ways discover.

I have couched several others who were born blind, whose observations were of the same kind; but they being younger, none of them gave so full an account as this gentleman.

CHAPTER V.

OF THE EAR.

THE figure and situation of the outer ear needs no description. Its inner substance is cartilage, which preserves its form without being liable to break. Its use is to collect sounds, and direct them into the meatus auditorius, which is the passage that leads to the drum; this passage is lined with a glandular membrane, in which also is some hair; the cerumen which is separated by these glands, being spread all over this membrane, and its hairs, serve to defend the membrane from the

outer air, and to entangle any insect that might otherwise get into the ear. Sometimes this wax being separated in too great quantity, it fills up the passage and causes deafness; and those great discharges of matter from the meatus auditorius, which are commonly called imposthumes in the ear, I think, can be nothing else but ulcerations, or great secretions from these glands. At the farther end of the meatus auditorius lies the membrana tympani, which is extended upon a bony ridge almost circular. Its situation in men and brutes is nearly horizontal, inclined towards the meatus auditorius, which is the best position to receive sounds; a great part of them being ordinarily reverberated from the earth. In men and brutes it is concave outward, but in birds it is convex outward, so as to make the upper side of it nearly perpendicular to the horizon, which seems fitter to hear each other's sounds when they are high in the air, where they can receive but little reverberated sound. This membrane does not entirely close the passage, but has on one side a small aperture covered with a valve. I found it once half open in a man that I dissected, who had not been deaf; and I have seen a man smoke a whole pipe of tobacco out through his ears, which must go from the mouth through the eustachian tube, and through the tympanum; yet this man heard perfectly well. These cases occasioned me to break the tympanum in both ears of a dog, and it did not destroy his hearing, but for

some time he received strong sounds with great horror. Mr. ST. ANDRE has assured me, that a patient of his had the tympanum destroyed by an ulcer, and the auditory bones cast out, without destroying his hearing. From these and other like cases it may be concluded, that the membrana tympani, though useful in hearing, is not the seat of that sense; and if any disease in that membrane should obstruct the passage of sounds to the internal parts of the ear, which are the seat of that sense, an artificial passage through that membrane might recover hearing, as the removing the crystalline humour, when that obstructs the light, recovers sight. Some years since a malefactor was pardoned on condition that he suffered this experiment, but he falling ill of a fever, the operation was deferred, during which time there was so great a public clamour raised against it that it was afterwards thought fit to be forbid. In very young children I have always found this membrane covered with mucus, which seems necessary to prevent sounds from affecting them too much, there being no provision to shut the ears, as there is for the eyes. A gentleman well known in this city, having had four children born deaf, was advised to lay blisters upon the heads of the next children he might have, which he did to three which were born afterward, and every one of them heard well. It seems not unreasonable to suppose that too great a quantity of this mucus upon the drum might be the cause of

deafness in the four children, and that the discharge made by the blisters in the latter cases was the cause of their escaping the same misfortune.

Into the middle of the tympanum is extended a small bone called malleus, whose other end is articulated to a bone called incus, which is also articulated by the intervention of an exceeding small one, called orbiculare, to a fourth bone called stapes. These bones are contained in that cavity behind the tympanum, which is called the barrel of the ear; but some anatomists call the barrel only tympanum, and the membrane membrana tympani. The malleus being moved inward by the musculus obliquus internus, or trochlearis, it extends the tympanum that it may be the more affected by impulse of sounds when they are too weak. This muscle rises from the cartilaginous part of the eustachian tube, and passing from thence in a proper groove, it is reflected under a small process, and thence passes on perpendicular to the tympanum, to be inserted into the handle of the malleus, sometimes with a double tendon. Parallel to this muscle lies another extensor of the tympanum, called obliquus externus; it arises from the outer and upper part of the eustachian tube, and passing through the same hole with the chorda tympani, which is a branch of the fifth pair of nerves, it is inserted into a long process of the malleus: this is not so obviously an extensor as to be known to be so without an experiment. The muscle

which relaxes this membrane is called externus tympani; it arises from the upper part of the auditory passage, under the membrane which lines that passage, and is inserted into the upper process of the malleus. The relaxation of the tympanum is made by this muscle, without our knowledge, when sounds are too strong; and as the pupil of the eye is contracted when we have too much light, and dilated when there is too little, from what cause soever, so when sounds are too low, or the sense of hearing imperfect, from whatever cause, the extensors of the tympanum stretch it to make the impulse of sounds more effectual upon it, just as in the case of the common drum, and the chords of any musical instrument. From the cavity behind the tympanum, which is called the barrel of the ear, goes the eustachian tube, or iter ad palatum; it ends cartilaginous behind the palate. This passage seems to be exactly of the same use with the hole in the side of the common drum, that is, to let the air pass in and out from the barrel of the ear to make the membrane vibrate the better, and perhaps in the ear, which is closer than a common drum, to let air in or out as it alters in density; and if any fluid should be separated in the barrel of the ear, to give it a passage out. This passage being obstructed, as it is sometimes, by a large polypus behind the uvula, it causes great difficulty of hearing, and sometimes, when the meatus auditorius is obstructed, a man

opening his mouth wide, will hear pretty well through this passage, which is often so open, as that syringing water through the nose, it shall pass through into the barrel of the ear, and cause deafness for some time. If any one would try how he can hear this way, let him stop his ears, and take between his teeth the end of a wire, or chord that will vibrate well, and holding the other end, strike it, and the sound that he hears will be through this passage. To the stapes there is one muscle, called musculus stapedis ; it lies in a long channel, and ending in the stapes, it serves so pull the stapes off of the fenestra ovalis, which otherwise it covers. Besides the fenestra ovalis, there is another near it, somewhat less, called rotunda ; these two holes lead to a cavity called vestibulum, which leads into other cavities aptly called cochlea, and three semicircular canals, or all together the labyrinth, in which are spread the auditory nerves, to receive and convey the impulse of sounds to the common sensorium the brain ; and surely the chorda tympani, which is a branch of the fifth pair of nerves, may also convey these sensations to the brain. The two holes, called fenestra ovalis and rotunda, are closed with a fine membrane, like the membrane called the drum, and the larger being occasionally covered and uncovered by the stapes, sounds are thereby made to influence more or less, as best serves for hearing ; and this advantage being added to that of a lax or tense tympa-

num, the effect of sounds may be greatly increased or lessened upon the auditory nerves, expanded in the labyrinth. In the strongest sounds, the tympanum may be lax, and the fenestra ovalis covered; and for the lowest, the tympanum tense, and the fenestra uncovered. If sounds propagated in the ear were heard less, we might often be in danger before we were apprised of it; and if the organs of hearing were much more perfect, unless our understandings were so too, we should commonly hear more things at once than we could attend to.

CHAPTER VI.

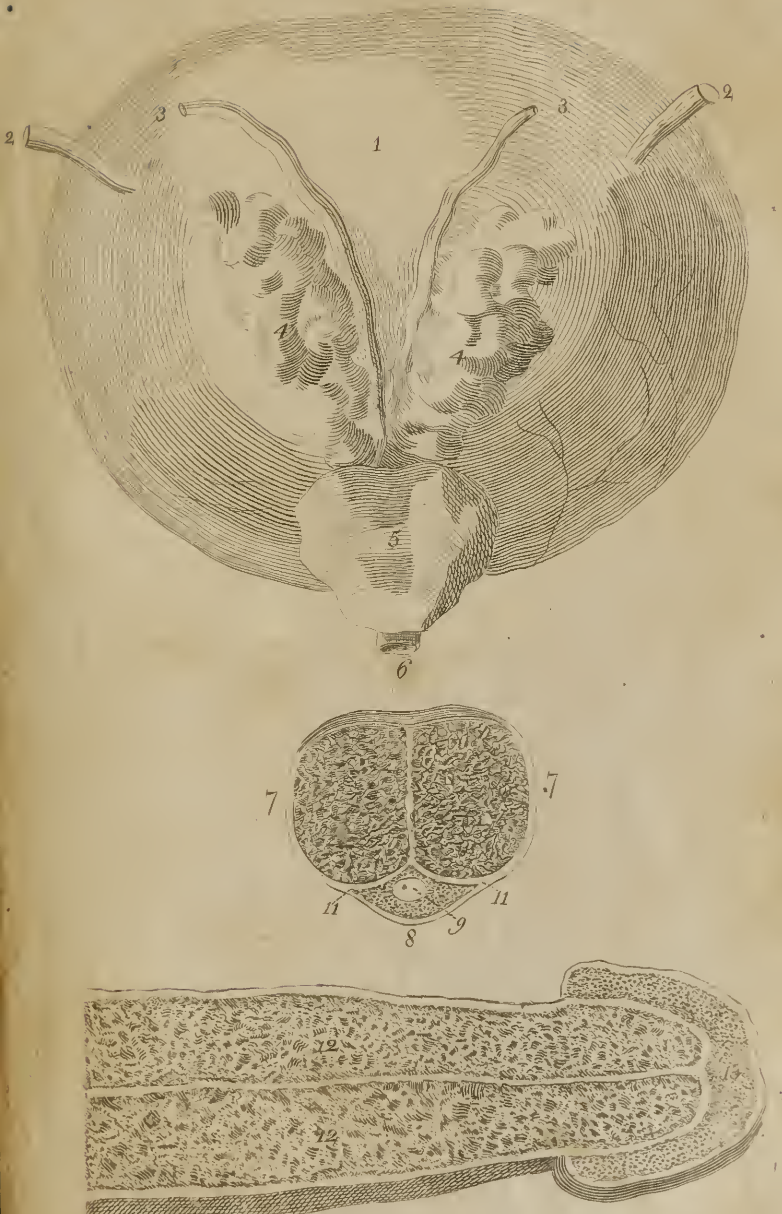
OF THE SENSES OF SMELLING, TASTING, AND FEELING.

THE sense of smelling is made by the effluvia, which are conveyed by the air to the nerves, ending in the membranes which line the nose and its lamellæ. In men these lamellæ are few, and the passage through the nose not difficult; hence fewer effluvia will strike the nerves, than in animals of more exquisite smell, whose noses being full of lamellæ, and the passage for the air narrow and crooked, few of the effluvia escape one place or another; besides, their olfactory nerves may be more sensible. Fish, though they have no noses, yet in their mouths they may taste effluvia in the water, as surely those fish do, who seek their prey

in the darkest nights, and in great depths of water, there being more nerves disposed in their mouths than through their whole bodies beside, the optic excepted; and it seems as if it was done for this purpose; for the mere sense of tasting is ordinarily less curious in them than in land animals; in baiting eel-baskets, if the bait has lain long in water, it is seldom followed; but upon scarifying it afresh, which will make it emit new effluvia, it serves as a fresh bait. The sense of tasting is made in the like manner upon the nerves which line the mouth, as is that of feeling upon the nerves distributed throughout the body; of which I should speak more in this place, if I had not done it already in the chapter of the nerves.

TABLE XXXI.

1 The under side of the bladder.
2 The ureters.
3 Vasa deferentia.
4 Vesiculæ seminales.
5 The prostrate gland.
6 Meatus urinarius.
7 A transverse section of the corpora cavernosa penis.
8 Corpus cavernosum urethræ.
9 Urethra.
10 Septum penis.
11 The septum between the corpus cavernosum urethræ, and that of the penis.
12 The corpora cavernosa penis divided by the septum.
13 Corpus cavernosum glandis.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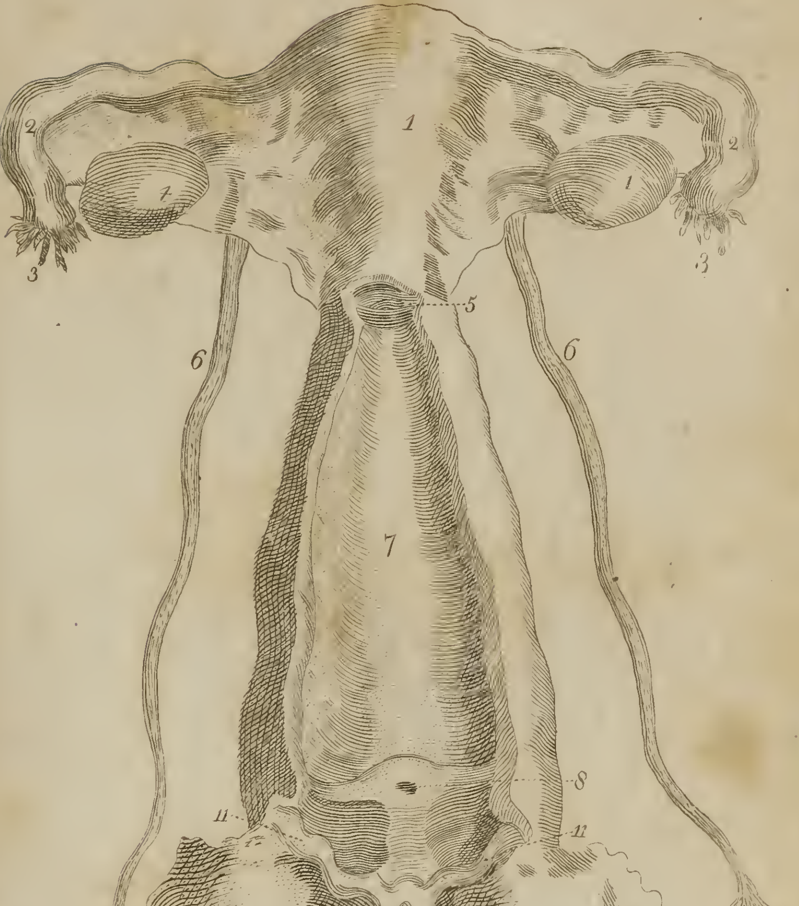
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TABLE XXXII.

1 That side of the uterus which is next the gut.
2 The fallopian tubes.
3 The fimbriæ.
4 Ovaria.
5 The mouth of the uterus.
6 Ligamenta rotunda.
7 The inside of the vagina.
8 The orifice of the meatus urinarius.
9 The glans clitoridis.
10 The external labia of the vagina.
11 The nymphæ, which are continued from the præputium clitoridis.

TABLE XXXIII.

The parts of an hermaphrodite negro, which was neither sex perfect, but a wonderful mixture of both. This person was twenty six years of age, and in shape perfectly male.

1 A clitoris, when erected, almost as large as a penis.

2 The glands of the clitoris.

3 Labia, or a divided scrotum; in which were perfect testicles with all the vessels.

4 Nymphæ.

5 The entrance into the vagina, where were carunculæ myrtiformes.

6 Furca virginis.

The lower figure represents another hermaphrodite, whose shape was rather female than male, but too young to have female breasts, or a beard, like a male, upon the face.

7 The glans clitoridis.

8 Nymphæ.

9 Labia with testicles in them, divaricated to shew the parts between, but in their natural situation very like the other, as the other when divaricated resembled this.

10 The entrance into the vagina.

11 Furca virginis.


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TABLE XXXIV.

1 The right ventricle of a fœtus distended with wax.
2 The right auricle.
3 The left auricle.
4 Branches of the pulmonary veins of the right lobe of the lungs, those of the left being cut off short.
5 The arteries of the left lobe of the lungs.
6 The vena cava descendens.
7 Aorta ascendens.
8 Arteria pulmonalis.
9 Ductus arteriosus.
10 The under side of a heart of a younger fœtus.
11 The right auricle cut open.
12 The cava descendens cut open.
13 Tuberculum Loweri.
14 The foramen ovale closed with its valve.
15 The mouth of the coronary veins.
16 The umbilical vein.
17 Branches of the vena porta in the liver.
18 Ductus venosus.
19 Branches of the cava in the liver.
20 Vena cava.

TABLE XXXV.

1 A cross for an object.

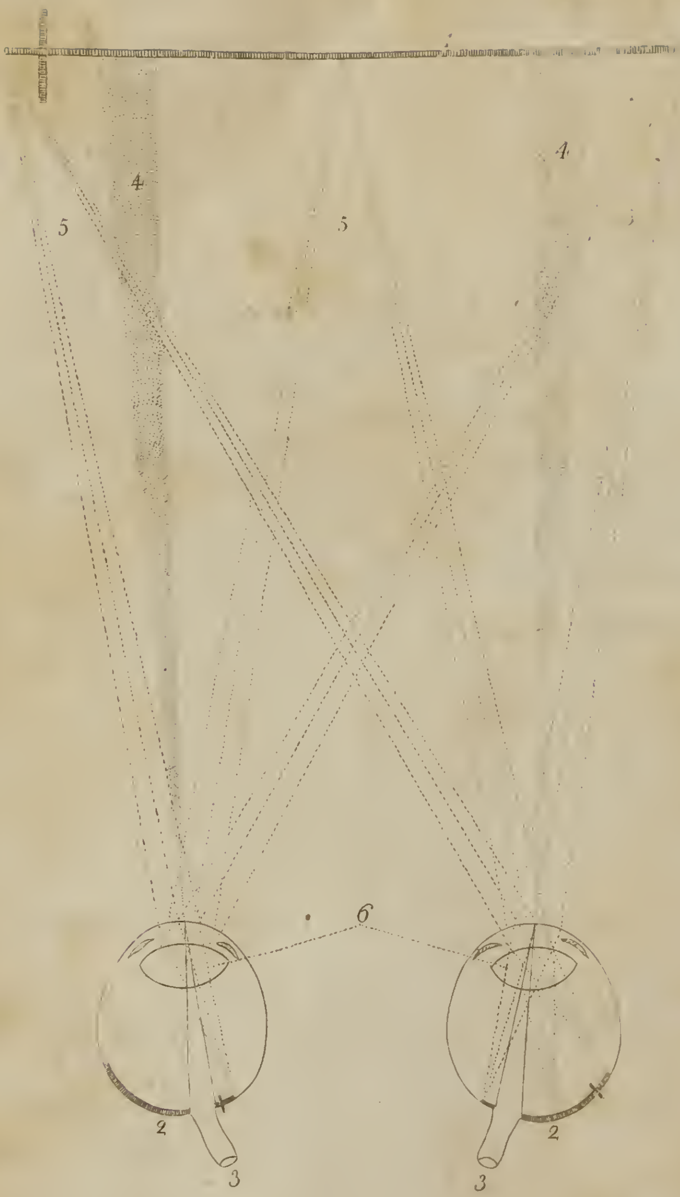
2 The object represented on the retina at the bottom of each eye.

3 The entrance of the optic nerves, in which place no object is represented.

4 Cones, within which all objects placed are dark to each eye, the rays from thence falling upon the entrance of the optic nerves; but that which falls upon the entrance of the optic nerve in one eye, can never fall upon the optic nerve in the other.

5 Pencils of rays from points of the object passing through the crystalline humour, where they converge, to meet in a point on the retina to form vision.

TAB. XXXV



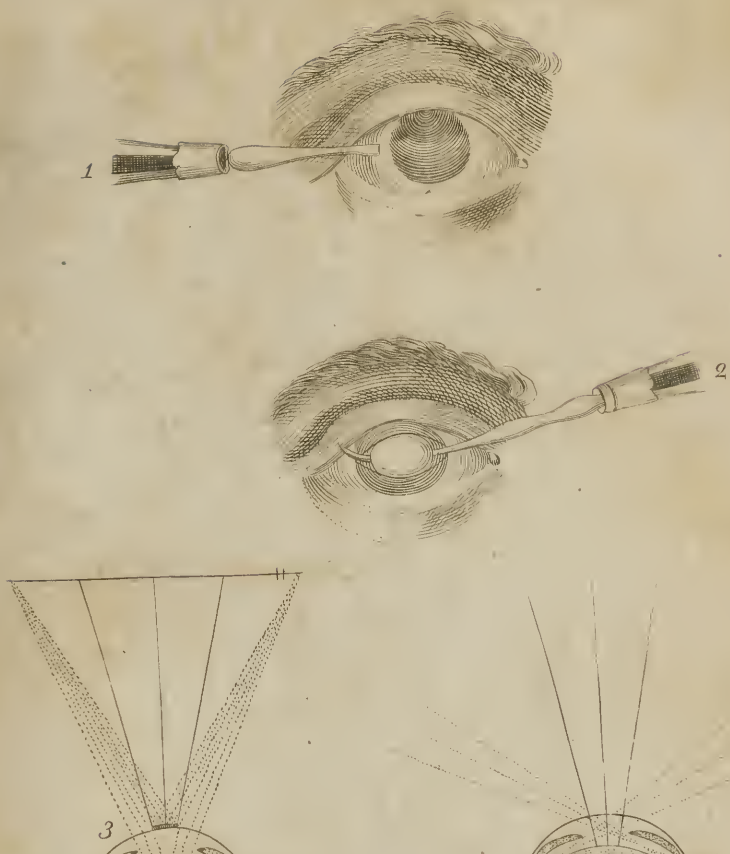

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TABLE XXXVI.

1 A knife passed through the tunica sclerotis, under the cornea before the iris, in order to cut an artificial pupil where the natural one is closed. This operation I have performed several times, with good success; indeed it cannot fail when the operation is well done, and the eye no otherwise diseased, which is more than can be said for couching a cataract. In this operation great care must be taken to hold open the eyelids without pressing upon the eye, for if the aqueous humour is squeezed out before the incision is made in the iris, the eye grows flaccid, and renders the operation difficult.

2 A crooked needle passed through a proptosis of the cornea; the black line in the cornea encloses the piece to be cut out with a knife. The operation being thus done, the crystalline humour immediately falls out; and in a few days the lips of the wound unite. This operation is very useful, and attended with but little pain. I have done the same thing when the whole eye has been so enlarged that the eyelids could not be closed, which has sunk the eye in the head; but this operation was attended with such violent pain that I cannot much recommend it.

3 Shews how an opaque scar upon the cornea, by obstructing part of each pencil of rays, makes a dimness of sight without a total loss.

4 Shews how a cataract or obstruction of the crystalline humour will obstruct the light which is before it. And how some side-light may pass to the retina through the aqueous humour, but not being brought into a focus gives only a sense of light without vision.

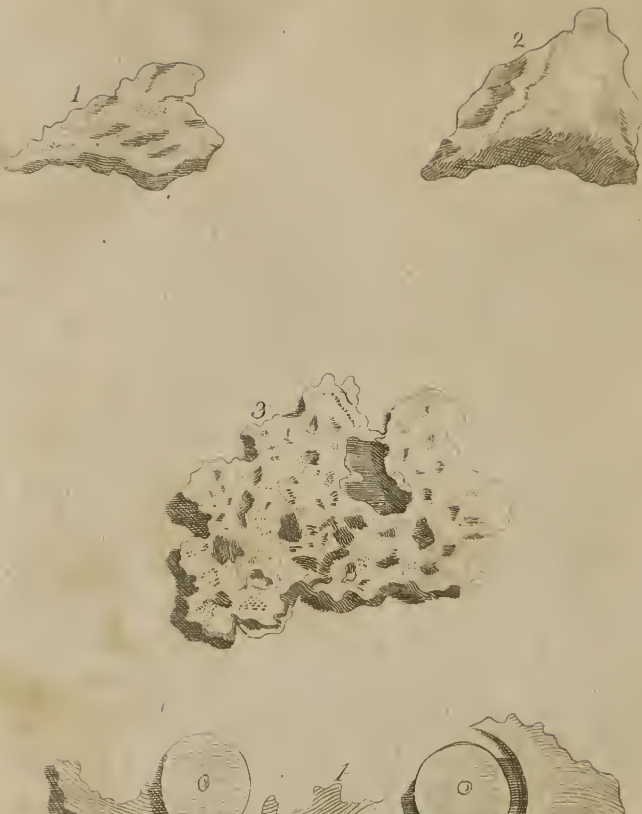
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TABLE XXXVII.

1 A bone taken out from the first process of the dura mater not far from the crista galli.

2 A bone taken out of the muscular part of the heart of a man.

3 The under side of a bone taken out of a fractured scull.

4 The upper side of a bone from the same scull, where the operation of the trepan had been thrice made. This girl was brought into the hospital a week after the accident. I immediately opened the scalp, and let out about two ounces of grumous blood, and laid the scull bare about four inches one way, and three the other, and tied the blood vessels, that I might make the operation without much difficulty soon after. The fracture extended across the os bregmatis from the sagittal suture to the temporal bone; that part next the os frontis was depressed equal to its thickness, and a great deal of extravasated blood, and some matter, lay under the other part of the same bone. I made two perforations with the trephine, close to the fracture, that I might raise it up steadily through both, and have more room for the extravasated blood to discharge from under the scull, which had discharged before in great quantity through the fracture. But

nevertheless, ten days after the former operation, I was obliged to make another perforation to discharge the matter more freely; for, during a month, the matter ran through all her dressings down her face twice every day, and was exceedingly fetid, and for the space of three months the matter decreased very little in quantity, but grew less and less offensive. September the thirteenth, the least of the bones was taken out; and on September the twenty ninth, the large one; after which time the matter was good, and not too much in quantity. Each of these bones is through both tables, for the motion in the brain was seen, only some little parts of the lesser bone remaining, a callus was formed from them; but where the great one came away there was no callus, only a common cicatrix; and besides these, many little bits of bone came away in the dressings: she was soon after cured, and has remained well many years.

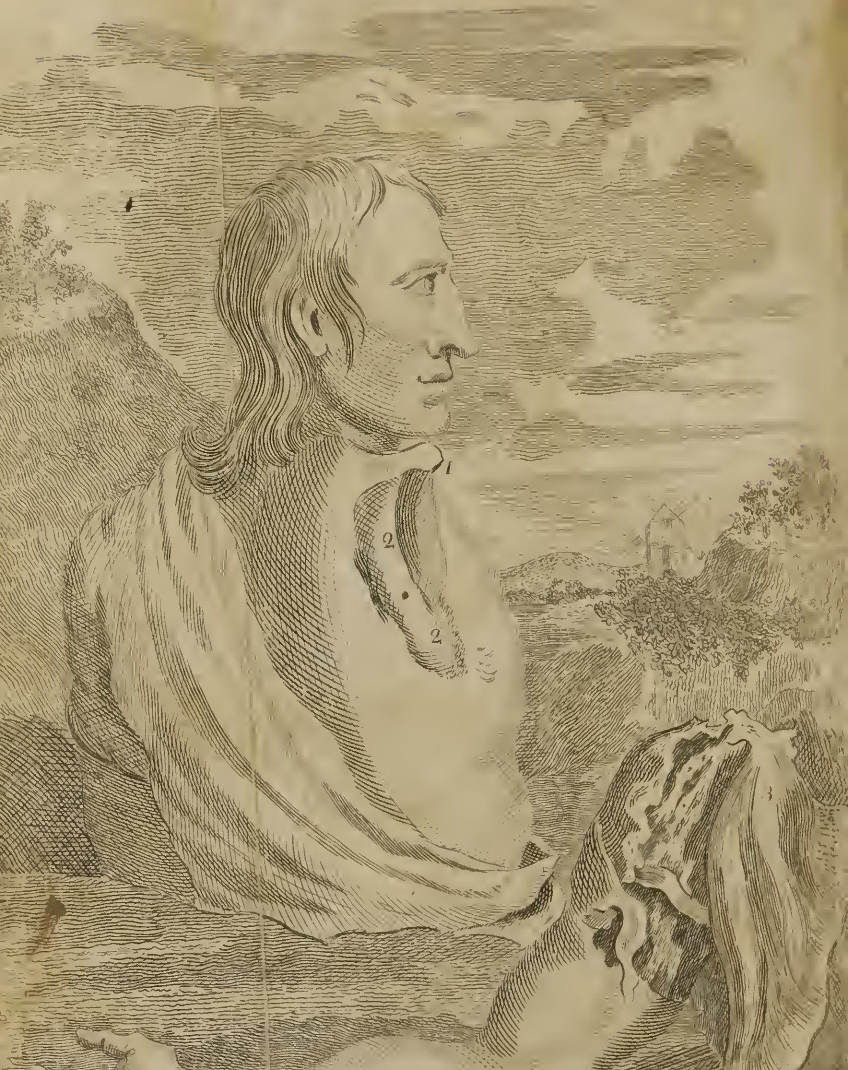
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TABLE XXXVIII.

The figure of SAMUEL WOOD, a miller, whose arm with the scapula was torn off from his body, by a rope winding round it, the other end being fastened to the coggs of a mill. This happened in the year 1737. The vessels being thus stretched bled very little, the arteries and nerves were drawn out of the arm; the surgeon who was first called placed them within the wound, and dressed it superficially. The next day he was put under Mr. FERNE's care, at St. Thomas's hospital, but he did not remove the dressings for some days. The patient had no severe symptoms, and the wound was cured by superficial dressings only, the natural skin being left almost sufficient to cover it; which should in all cases be done as much as may be. About twenty years since I introduced the method of amputating, by first dividing the skin and membrana adiposa, lower than the place where the operation was to be finished, the advantages of which are now sufficiently known.

1 The end of the clavicle.

2 The cicatrix.

3 The subscapularis muscle.

4 The cubit broke in two places.

TABLE XXXIX.

Represents the case of JOHN HEYSHAM, who, the Friday before Easter, in the year 1721, by overstraining himself at work, had a rupture of the intestines into the scrotum, which could by no means be reduced. He was brought into St. Thomas's hospital the Monday following, and I would have performed the operation immediately, but he refusing to submit, it was deferred till Tuesday morning, when, he being willing, I performed the operation, and making a large wound in the bottom of the abdomen, the intestines were easily reduced, and near a quart of water was discharged out of the scrotum at the same time. There had been a rupture of the omentum before, which being united to the scrotum and spermatic vessels, I passed a needle with a double ligature (as is expressed in the plate) under that part of the omentum that adhered, so as not to hurt the spermatic vessels; then cutting out the needle, I tied one of the strings over the upper part of the omentum, and the other over the lower, and then cut off as much of it as was in the way. My reason for tying in this manner was to secure the blood vessels, which, I think, could not be done so well with one ligature, because of the largeness of


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the adhesion and the texture of the omentum, which renders it too liable to be torn by such a bandage. Three days after the operation an erysipelas began in his legs, and spread all over his body, the cuticle every where peeling off; yet he recovered, and continues in a good state of health. After he was cured, at first he wore a small truss, but left it off in a short time, and now feels no inconvenience from it, though he lives by hard labour.

TABLE XL.

The case of MARGARET WHITE, the wife of JOHN WHITE, a pensioner in the Fishmongers alms-houses at Newington in Surry. In the fiftieth year of her age, she had a rupture at her navel, which continued till her seventy-third year, when, after a fit of the colic, it mortified, and she being presently after taken with a vomiting, it burst. I went to her, and found her in this condition, with about six and twenty inches and a half of the gut hanging out, mortified. I took away what was mortified, and left the end of the sound gut hanging out at the navel, to which it afterwards adhered; she recovered and lived many years after, voiding the excrements through the intestine at the navel; and though the ulcer was so large, after the mortification separated, that the breadth of two guts was seen; yet they never at any time protruded out at the wound, though she was taken out of her bed, and sat up every day.

1 The gut.

2 The cicatrix of the wound.

TAB. XL. P. 324.

CHAPTER VII.

A SHORT HISTORICAL ACCOUNT OF CUTTING FOR THE STONE.

THE most ancient way of cutting for the stone is that described by CELSUS, which was indeed cutting upon the gripe, but in a very different manner from that operation in later ages, for he directs a lunated incision with the horns towards the coccyges, which was plainly that the gut might be pressed downwards to avoid wounding it, and then a transverse incision upon the stone might be made safely, but not in very young children, for want of room, nor after puberty, for then the prostatæ are too large to allow of this operation; therefore they did not usually cut any younger than nine years, nor older than fourteen. Afterwards, but when we know not, this operation was improved by cutting lower, and on one side, which is the operation now called cutting on the gripe, or with the lesser apparatus.

In the year 1524, MARIANUS published the method of cutting by the greater apparatus, now commonly called the old way, but he owns it was invented by his master JOHANNES DE ROMANIS.

In the year 1697, FRERE JACQUES came to Paris, full of reputation for the success of his new operation for the stone; he soon obtained leave to cut in the hospitals, where great numbers of his

patients dying, and being dissected, they were found with their bladders cut through, guts wounded, &c. which brought the operation into disgrace, as MERY and DIONIS have related, who saw these things. They say he performed the operation without any direction, and without any knowledge of the parts he was to cut; a thing not to be mentioned without horror! But of late his character has been set in a very different light; and though it is more than probable he himself knew not what he did, yet there are now, who pretend to tell us exactly; though if their testimonies are to be regarded, who saw him operate, there is no place that he did not cut one time or other, and therefore he may have a sort of right to be called the inventor of any operation for the stone that can ever be performed in these parts. It is also owned that he sometimes had great success, which was enough to put others of that nation upon trying of it in a more judicious manner; but if there were such, failing of success, they have concealed their experiments.

Mr. RAU of Amsterdam, who saw F. JACQUES operate, professed to do his operation with the necessary improvement of a grooved staff, which if JACQUES ever used, he surely learned that of RAU. He succeeded wonderfully; and if he, who was an excellent anatomist, may be allowed to understand his own operation, it was directly into the bladder, without wounding either the urethra

or the prostrates: besides this, other competent judges, who were witnesses to his operations, have bore the same testimony.

In the year 1717-18, Doctor JAMES DOUGLASS, in a paper presented to the Royal Society, demonstrated from the anatomy of the parts, that the high operation for the stone might be practised; which had been once performed by FRANCO injudiciously, and by him disrecommended, though his patient recovered; and afterwards strongly recommended, but not practised by ROSSET. Yet no one undertook it, till his brother, Mr. JOHN DOUGLASS, about three years after, performed it, and with great applause, his two first patients recovering. Soon after, a surgeon of St. Thomas's hospital cut two, who both recovered; but the same gentleman afterwards cutting two, who miscarried by the cutting or bursting of the peritonæum, so that the guts appeared, this way immediately became as much decried as it was before commended; upon which the surgeons of St. Bartholomew's hospital, who had prepared to perform this operation, altered their resolution, and went on in the old way. The next season, it being my turn in St. Thomas's, I resumed the high way, and cutting nine with success, it came again in vogue; after that every lithotomist of both hospitals practised it; but the peritonæum being often cut or burst twice in my practice, though some of these recovered, and sometimes the

bladder itself was burst, from injecting too much water, which generally proved fatal in a day or two. Another inconvenience attended every operation of this kind, which was, that the urine's lying continually in the wound retarded the cure, but then it was never followed with an incontinence of urine. What the success of the several operators was, I will not take the liberty to publish; but for my own, exclusive of the two before mentioned, I lost no more than one in seven, which is more than any one else that I know of could say; whereas in the old way, even at Paris, from a fair calculation of above 800 patients, it appears that near two in five died. And though this operation came into universal discredit, I must declare it my opinion, that it is much better than the old way, to which they all returned, except myself, who would not have left the high way but for the hopes I had of a better; being well assured, that it might hereafter be practised with greater success; these fatal accidents having pretty well shewn how much water might be injected, and how large the wound might safely be made. But hearing of the great success of Mr. Rau, professor of anatomy at Leyden, I determined to try, though not in his manner, to cut directly into the bladder; and as his operation was an improvement of Friar Jacques, I endeavoured to improve upon him, by filling the bladder, as Douglass had done in the high way, with water,

leaving the catheter in, and then cutting on the outside of the catheter into the bladder, in the same place as upon the gripe, which I could do very readily, and take out a stone of any size with more ease than in any other way. My patients, for some days after the operation, seemed out of danger; but the urine which came out of the bladder continually lodging upon the cellular membrane on the outside of the rectum, made fœtid ulcers, attended with a vast discharge of stinking matter: and from this cause I lost four patients out of ten. The case of one which escaped was very remarkable; a few days after he was cut, he was seized with a great pain in his back and legs, with very little power to move them; upon which he turned upon his face, and rested almost constantly upon his knees and elbows above a fortnight together, having no ease in any other posture all that while; at length his urine coming all the right way, his wound soon healed, and he recovered the use of his back and limbs. I think all these severe symptoms could proceed from no other cause than the urine and matter somehow offending the great nerves; which come out of the os sacrum to go to the lower limbs. I then tried to cut into the bladder, in the same manner that Mr. Rau was commonly reported to do, but there had the same inconvenience from the urine's lodging upon the cellular membrane on the outside of the intestinum rectum. Upon these dis-

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appointments, I contrived the manner of cutting, which is now called the lateral way. This operation I do in the following manner: I tie the patient as for the greater apparatus, but lay him upon a blanket several doubles upon an horizontal table three feet high, with his head only raised. I first make as long an incision as I can, beginning near the place where the old operation ends, and cutting down between the musculus accelerator urinæ, and erector penis, and by the side of the intestinum rectum: I then feel for the staff, holding down the gut all the while with one or two fingers of my left hand, and cut upon it in that part of the urethra which lies beyond the corpora cavernosa urethræ, and in the prostate gland, cutting from below upwards, to avoid wounding the gut; and then passing the gorget very carefully in the groove of the staff into the bladder, bear the point of the gorget hard against the staff, observing all the while that they do not separate, and let the gorget slip to the outside of the bladder; then I pass the forceps into the right side of the bladder, the wound being on the left side of the perinæum; and as they pass, carefully attend to their entering the bladder, which is known by their overcoming a straitness which there will be in the place of the wound; then taking care to push them no farther, that the bladder may not be hurt, I first feel for the stone with the end of them, which having felt,

I open the forceps and slide one blade underneath it, and the other at top; and if I apprehend the stone is not in the right place of the forceps, I shift it before I offer to extract, and then extract it very deliberately, that it may not slip suddenly out of the forceps, and that the parts of the wound may have time to stretch, taking great care not to gripe it so hard as to break it, and if I find the stone very large, I again cut upon it as it is held in the forceps. Here I must take notice, it is very convenient to have the bladder empty of urine before the operation, for, if there is any quantity to flow out of the bladder at the passing in of the gorget, the bladder does not contract but collapse into folds, which makes it difficult to lay hold of the stone without hurting the bladder; but if the bladder is contracted, it is so easy to lay hold of it, that I have never been delayed one moment, unless the stone was very small. Lastly, I tie the blood vessels by the help of a crooked needle, and use no other dressing than a little bit of lint besmeared with blood, that it may not stick too long in the wound, and all the dressings during the cure are very slight, almost superficial, and without any bandage to retain them; because that will be wetted with urine, and gall the skin. At first I keep the patient very cool to prevent bleeding, and sometimes apply a rag dipt in cold water, to the wound, and to the genital parts, which I have found very useful in hot

weather particularly. In children it is often alone sufficient to stop the bleeding, and always helpful in men. The day before the operation, I give a purge to empty the guts, and never neglect to give some laxative medicine or clyster a few days after, if the belly is at all tense, or if they have not a natural stool. What moved me to try this way, if I may be allowed to know my own thoughts, was the consideration of women scarce ever dying of this operation; from which I concluded, that if I could cut into the urethra, beyond the corpora cavernosa urethræ, the operation would be nearly as safe in men as women.

What success I have had in my private practice I have kept no account of, because I had no intention to publish it, that not being sufficiently witnessed. Publicly in St. Thomas's hospital I have cut two hundred and thirteen; of the first fifty, only three died; of the second fifty, three; of the third fifty, eight; and of the last sixty three, six. Several of these patients had the smallpox during their cure, some of whom died, but I think not more in proportion than what usually die of that distemper; these are not reckoned among those who died of the operation. The reason why so few died in the two first fifties was, at that time few very bad cases offered; in the third, the operation being in high request, even the most aged and most miserable cases expected to be saved by it; besides, at that time, I made the operation

lower, in hopes of improving it, but found I was mistaken. But what is of most consequence to be known is the ages of those who recovered, and those who died. Of these, under ten years of age one hundred and five were cut, three died ; between ten and twenty, sixty two cut, four died ; twenty and thirty, twelve cut, three died ; thirty and forty, ten cut, two died ; forty and fifty, ten cut, two died ; fifty and sixty, seven cut, four died ; sixty and seventy, five cut, one died ; between seventy and eighty, two cut, one died. Of those who recovered the three biggest stones were ℥ xii, x¼, and viii, and the greatest number of stones in any one person was thirty three. One of the three that died out of the hundred and five, was very ill with a whooping cough ; another bled to death by an artery into the bladder, it being very hot weather at that time : but this accident taught me afterwards, whenever a vessel bled that I could not find, to dilate the wound with a knife, till I could see it. Now if JACQUES or others, who of late have been said to have performed this operation, whether by design or chance, did not take care to secure the blood vessels, which as yet has not been supposed, whatever their dexterity in operating might be, their suceess at least can be no secret, for many of their children and most of their men patients must have bled to death. If I have any reputation in this way,

I have earned it dearly, for no one ever endured more anxiety and sickness before an operation, yet from the time I began to operate, all uneasiness ceased; and if I have had better success than some others, I do not impute it to more knowledge, but to the happiness of a mind that was never ruffled or disconcerted, and a hand that never trembled during any operation.

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FINIS.